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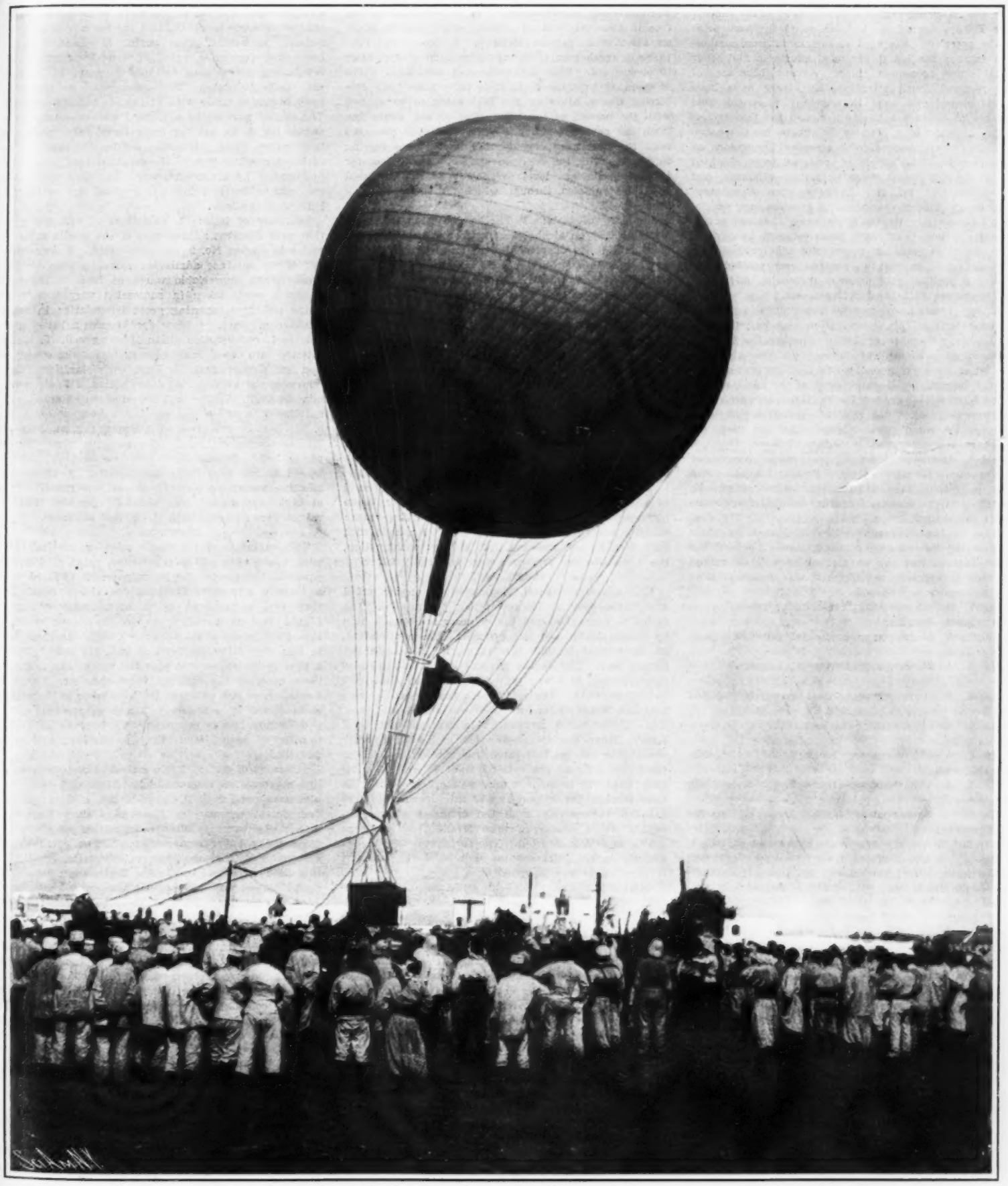


A CAPTIVE BALLOON IN USE BY THE FRENCH FORCES IN MOROCCO.

THE BALLOON IN WARFARE.—[See page 312.]

ALCOHOL FOR OPERATING ENGINES.

OFFICIAL TESTS OF INTERNAL COMBUSTION ENGINES ON ALCOHOL FUEL.

A REPORT upon an elaborate series of tests of internal-combustion engines on alcohol fuel has been prepared for the Department of Agriculture by Charles E. Lucke, assistant professor of mechanical engineering, Columbia University, and S. M. Woodward, of the Office of Experiment Stations. A brief report upon a few preliminary tests was published some months ago, but the data obtained were so incomplete and inconclusive that the work was recently again undertaken on a much more comprehensive basis, with results that will no doubt attract very general attention among power users. Through the courtesy of the Department, the correspondent of the Iron Age is enabled to present the following synopsis of this interesting report:

In Europe during the last ten years the high price of the petroleum oils used as fuel in internal-combustion engines has led to extended efforts to find other suitable and economical fuels. Among these alcohol has received much attention, and there have been manufactured and used in Germany a considerable number of engines specially designed for this fuel.

The question of a possible substitute for the petroleum fuels will become of increasing importance as time goes on. The supply of crude oil to be obtained in the United States must ultimately diminish, and the history of the past indicates that a constant increase in price of kerosene and gasoline may reasonably be expected. On the other hand, it is not unreasonable to hope that with improvements in agriculture and in processes of manufacture the cost of alcohol may fall, so that as regards cost alcohol may occupy a position of constantly increasing advantage in comparison with the petroleum oils.

OBJECTS OF THE INVESTIGATION.

The objects of this investigation may be put under two heads: First, to determine whether the gasoline and kerosene engines at present on the American market can run on alcohol as fuel. This involved, as related matters, the determination of the manipulation to be followed in making the engines run on alcohol, the measurement of the relative maximum powers of the engines when using alcohol and the fuels for which they were originally made, and, lastly, the relative consumptions of the different fuels. Second, to determine, so far as the limited time and means available permitted, the improvements which might be desirable in the design of engines manufactured especially for alcohol.

Most of the engines used were loaned by their makers for the purpose of these tests. Each of the eight engines was run on alcohol as well as on the gasoline or kerosene for which it was designed. The engines used were:

No. 1. A 15-horse-power two-cylinder vertical four-cycle gasoline engine.

No. 2. A 6-horse-power horizontal four-cycle gasoline engine.

No. 3. A 6-horse-power horizontal four-cycle gasoline engine.

No. 4. A 6-horse-power vertical four-cycle gasoline engine.

No. 5. A 6-horse-power horizontal two-cycle kerosene engine.

No. 6. A 40-horse-power four-cylinder automobile gasoline engine.

No. 7. A 40-horse-power four-cylinder automobile gasoline engine.

No. 8. A 2-horse-power vertical two-cycle marine gasoline engine.

The last three, of course, were high-speed engines.

On engine No. 1 fifteen tests are reported, giving the consumption of alcohol and gasoline under different brake loads and with different initial compressions.

With engine No. 2 twenty-four tests are reported with gasoline and thirty tests with alcohol. These show the effect upon consumption and upon the shape and size of the indicator cards of changes in fuel, needle valve setting, time of ignition and brake load.

For engine No. 3 eighteen tests with gasoline and nineteen with alcohol are given. These show the effect upon fuel consumption, mean effective pressure, and uniformity of explosions, of changes in brake load, needle valve setting, time of ignition, and engine speed.

With engine No. 4 eleven tests on gasoline and twenty-six on alcohol show the relative consumptions and powers with the two fuels under different settings of air and fuel valves, and also the effect of heating the air in advance of its entrance to the carbureter.

With engine No. 5 four tests with kerosene and five with alcohol show the relative maximum power obtainable with the two fuels and the corresponding fuel consumptions. They also give some indication of how the fuel consumption is affected by different conditions of the engine's operation.

With engine No. 6 two runs on each fuel, gasoline and alcohol, show the relative power and fuel consumptions obtained with the two fuels.

With engine No. 7 twelve tests with gasoline and seven with alcohol show the consumptions with different loads and with different valve settings.

On engine No. 8 ten tests using gasoline and seven using alcohol show the relative consumptions of the two fuels and the relative powers obtained under different adjustments of the engine.

ENGINE NO. 1.

The engine is rated at 15 horse-power at 280 revolutions per minute. It is two-cylinder, single-acting, vertical, four-cycle, 6½-inch bore and 10-inch stroke. Each cylinder has two valves set in the main casing. One of these valves is an exhaust valve, and the other an inlet valve for the mixture. Besides these two, there is another valve for the admission of fuel after it is gasified. This last-mentioned admission valve is operated from the main inlet valve stem by a projecting finger, allowing the fuel valve to be opened with the motion of the inlet valve or not, depending upon the governor action. When the speed rises too high the governor prevents this finger from coming in contact with the fuel valve stem. The carbureter is of the constant level overflow type, and is fitted with sight glasses, through which the fuel level may be observed.

Summary of tests: 1. The engine runs as easily and smoothly on alcohol as on gasoline, and probably more noiselessly on alcohol than on gasoline. 2. The usual gasoline carbureter may be used for alcohol, but with this carbureter the alcohol is not completely vaporized and passes into the cylinder partly in liquid form. 3. The maximum power of the engine is distinctly greater with alcohol fuel than with gasoline. 4. Higher compression may be used with alcohol for fuel than with gasoline. 5. The consumption of fuel per brake horse-power, whether measured by weight or by volume, was much greater with alcohol than with gasoline. 6. With either fuel it is very easy to use, through wrong adjustments, much more fuel than the minimum amount necessary. 7. High compression gives a slight improvement in fuel consumption, but this improvement may very easily be more than overcome by wrong adjustment of the fuel supply. 8. The lowest consumptions obtained were 0.71 pound of gasoline and 1.12 pounds of alcohol per brake horse-power hour. 9. The highest working mean effective pressure obtained was about 90 pounds with both alcohol and gasoline, but at best consumption, the mean effective pressures were materially lower.

ENGINE NO. 2.

This was a horizontal, single-cylinder engine, rated at 6 horse-power at 300 revolutions per minute. The action is four-cycle, and the cylinder is 5½-inch bore by 9-inch stroke, and water-cooled. The compression, as determined by indicator cards, is 73 pounds per square inch. The engine governs by the hit-and-miss principle, but in a way quite different from that used in engine No. 1. The inlet valve is operated by suction and is not under control of the cam at any time. The exhaust valve, however, is a cam operated by a lever. When the speed gets too high the governor operates to prevent this valve from closing, and at the same time a finger prevents the inlet valve from opening. This will result in a miss stroke, and during the miss strokes the exhaust gases are drawn into and expelled successively from the cylinder, whereas in engine No. 1, during a miss stroke fresh air was drawn in and passed out. The carbureter is attached directly to the inlet opening and is of the constant level overflow type, supplied by a pump.

Summary of tests: 1. With both alcohol and gasoline fuel, from half load to full load, the best consumptions were obtained with the smallest needle valve settings which could be used with the respective fuels and loads. 2. With both alcohol and gasoline fuel, by opening the needle valve the consumption could be increased to approximately twice the best consumption before the engine would be stopped by the excess of fuel. 3. With both alcohol and gasoline, the most rapid combustion, the highest mean effective pressure and the highest maximum pressure were obtained when the fuel used was considerably in excess of the best consumption. 4. With both alcohol and gasoline the amount of fuel used with any given load was approximately proportional to the needle valve setting. 5. The minimum needle valve setting for alcohol was about double the minimum setting for gasoline and about equal to the maximum setting possible for the same load with gasoline. 6. With alcohol fuel, using a slow burning dilute fuel mixture, the consumption was perceptibly improved by using a very early ignition. 7. The mean effective pressure and the maximum explosion pressure were about the same for both alcohol and gasoline at best consumption. 8. The highest mean effective pressures obtained with alcohol were appreciably greater than the highest obtained with gasoline. 10. Much more alcohol could be supplied to the engine cylinder than would be vaporized in the carbureter, so that liquid alcohol entered the cylinder. 11. With alcohol the engine would run on a greater range of misadjustment than with gasoline. 12. The best consumption results obtained were 0.69 pound of gasoline and 1.23 pounds of alcohol, respectively, per brake horse-power hour. 13. At best consumptions the mean effective pressures were 90 pounds for both alcohol and gasoline.

ENGINE NO. 3.

This engine is very similar to engine No. 2 in size, structure and method of operation, although its valve gear is different in details and the carbureter is quite different in action. This engine is single cylinder, horizontal, four-cycle, rated at 6 horse-power at 340 revolutions per minute, cylinder diameter 5½ inches, and stroke 10 inches. The compression, as measured from indicator cards, was 82 pounds per square inch. The engine governs by a method quite similar to the engine No. 2, by holding the exhaust valve open, the inlet valve being automatic suction operated. The carbureter, while it is of the constant level type, does not operate by a suction spray. In other words, the spraying orifice is below the level of the overflow a little over one inch.

Summary of tests: 1. Variations of fuel consumption with different adjustments of the needle valve as found in engine No. 2 were confirmed. 2. Any opening of the mixture admission valve on miss strokes produced an appreciable waste of fuel. 3. Different indicator cards taken in succession vary greatly in shape and area, showing great irregularity in mean effective pressure. 4. Slow speeds gave a better alcohol fuel consumption than high speed. 5. Water injected into the exhaust pipe increased the consumption of alcohol fuel. 6. Very early ignition much improved the alcohol fuel consumption with the weak mixture used. 7. The best consumption obtained with gasoline was 0.85 pound per brake horse-power hour. 8. The best consumption with alcohol fuel at 320 revolutions per minute was 1.25 pounds per brake horse-power hour. A slightly better consumption was obtained at 200 revolutions per minute. 9. The mean effective pressure with both alcohol and gasoline fuel at best consumption was about 74 pounds. Higher values were obtained with richer fuel mixtures.

ENGINE NO. 4.

This engine is of the single cylinder, vertical type, with 6-inch bore and 8-inch stroke, rated at 6 horse-power at 350 revolutions per minute. It is fitted with a throttle governor, designed for closer regulation than can be secured by a hit-and-miss governor. Liquid fuel is supplied, as in the other engines, through a pump about on a level with the shaft and in line with left-hand flywheel hub. It rises through a pipe to the carbureter near the top of the cylinder, there entering the constant level chamber. Gasoline flowing from this constant level chamber to the orifice is regulated by a needle valve, as in previous cases, and the flow is a weak suction flow, because the orifice is about ¾ inch higher than the constant level overflow pipe.

Summary of tests: 1. No entirely satisfactory gasoline consumption tests could be obtained, because the high compression of 128 pounds produced preignition and violent hammering. Short runs showed approximately the same gasoline consumption as other engines using lower compression. 2. The operation of the engine with alcohol was entirely satisfactory with this high compression. 3. The best alcohol consumption obtained was 1.13 pounds per brake horse-power hour. 4. As compared with the other engines tested, there was only a slight improvement in consumption, due to the higher compression used. 5. Any slight error in the regulation or adjustment of the engine would much outweigh the benefit of increased compression on the fuel consumption. 6. The maximum mean effective pressure obtained was about 97 pounds at best consumption. 7. With the air entering the carbureter heated to 125 deg. F., the engine would self-ignite with alcohol fuel. 8. This preignition caused no hammering in the engine cylinder, and was in no way objectionable in the operation of the engine. 9. With the air entering the carbureter heated to 150 deg. F., preignition took place so early as to reduce the maximum power of the engine, but otherwise it continued to run satisfactorily. 10. The use of heated air produced no appreciable change in the fuel consumption. 11. With the air heated to 125 deg., the maximum mean effective pressure at best consumption was about 93 pounds.

ENGINE NO. 5.

This engine is designed for kerosene, whereas all the engines previously described are intended for gasoline. It is a single-cylinder, horizontal engine, two-

cycle, with crank-case compression. The head-end compression, as determined from indicator cards, is 84 pounds per square inch. It is rated at 6 horse-power at 360 revolutions per minute, having a cylinder diameter of 7 inches and a stroke of 8 inches. The engine has no carbureter, but is fitted up with a separate vaporizing chamber. Oil is supplied to a pump on top of the engine, which delivers it directly through a pipe to the vaporizer lip. This pump also has a hand-operated handle to deliver oil in starting.

Summary of tests: 1. To run the engine satisfactorily on alcohol it is necessary that the fuel-injection mechanism be slightly modified. 2. When properly arranged for alcohol, this engine can be started as readily and operated as satisfactorily on alcohol as on kerosene. 3. With kerosene it is absolutely necessary to keep the bulb cool by some means, and the steam injection satisfactorily accomplishes this result. 4. With alcohol the bulb tends to become too hot, and it would probably be advantageous to use some means for cooling it. 5. The maximum power obtainable from the engine with alcohol is greater than the maximum with kerosene. 6. The best consumption obtained with kerosene was 0.98 pound per brake horse-power hour. 7. The best consumption obtained with alcohol was 1.60 pounds per brake horse-power hour.

ENGINE NO. 6.

This engine is of the automobile type, four-cycle, single-acting, vertical, rated at 40 horse-power at 900 revolutions per minute, each cylinder having 4¾-inch bore and 5¾-inch stroke. All of the valves are cam operated, and the carbureter is of the constant level type. This engine is the latest development of the works of the original developer of the high-speed engine. Gasoline enters the carbureter through a pipe, under a light pressure, obtained usually in automobiles by pumping air into the gasoline tank or by connecting the tank with the exhaust pipe by small pipe and check valve, thus regulating the pressure in the gasoline tank without the use of an air pump. The operation of this engine was so unsatisfactory that no summary of tests is submitted therefor.

ENGINE NO. 7.

This engine has four cylinders, each of 4⅝-inch bore and 5 3/16-inch stroke, and is rated at 40 horse-power at 900 revolutions per minute. The engine has a cam-operated exhaust valve and automatic suction inlet valve, in this respect being different from engine No. 6. It is also different in having jump spark ignition instead of make and break ignition, but these are matters of very little importance on the relative performance of gasoline and alcohol fuel. Gasoline enters this carbureter, as in previous cases, by way of a float chamber, which controls the level of the gasoline, and from the float chamber to a spraying orifice controlled by a needle valve. There is, as in the carbureter of engine No. 6, a sliding throttle, with opening arranged with respect to the spraying orifice. The amount of gasoline spray is regulated by the needle valve having a fine taper and is otherwise dependent upon the vacuum in the carbureter chamber.

Summary of tests: 1. As satisfactory operation of the engine and as high a power was obtained when the engine was running on alcohol fuel as when it was using gasoline fuel. 2. When alcohol was used, but a small proportion of the liquid was vaporized in the carbureter. The remainder of the fuel supplied must have been carried along with the air as a liquid spray. This was shown by the low temperature of the fuel mixture after leaving the carbureter, and also by the fact that at low loads not all the cylinders could get an explosive mixture. 3. The fuel consumption per brake horse-power hour was increased by opening materially either the fuel needle valve or the throttle valve beyond the settings necessary to carry the load. 4. With gasoline fuel the consumption per brake horse-power hour did not appear to vary so much with the load as it did when alcohol fuel was used. 5. With gasoline fuel the best consumption was 0.69 pound per brake horse-power hour. 6. With alcohol fuel the best consumption obtained was 1.30 pounds per brake horse-power at the highest load obtained—18 brake horse-power.

ENGINE NO. 8.

This engine is a small boat engine, single cylinder, vertical, two-cycle, rated at 2 horse-power at 700 revolutions per minute, having a cylinder diameter of 4 inches and a stroke of 4 inches. The carbureter is so attached that on every up stroke of the piston a mixture is drawn into the crank case. At the same time the compression charge is being compressed in the cylinder. The exhaust takes place through a port very similar to that of engine No. 5, and the moisture sucked in and compressed in the crank case is transferred from the crank case to the cylinder proper by a small port. The cylinder is water jacketed, and provided with a pump to maintain water circulation. Gasoline must be brought to this carbureter under a light pressure, as there is no gasoline pump. The carbureter is of the constant level type, the level being maintained by a float in the gasoline.

Summary of tests: 1. This engine was as easily started, and ran as smoothly and satisfactorily on alcohol as on gasoline. 2. The maximum power of the engine seemed to be greater with alcohol than with gasoline. 3. As the brake load in pounds is changed through a considerable range, the speed varies in the inverse manner so that the power remains nearly constant. 4. Much more fuel than the minimum amount necessary may be used by improper settings of the engine adjustment. 5. At full load the engine is very sensitive to slight changes in the conditions of ignition. 6. When alcohol fuel is used, if the crank case is cold, liquid alcohol collects therein, and may be subsequently vaporized as the crank case becomes hot. 7. The best consumption obtained on gasoline was 1.36 pounds per brake horse-power hour. 8. The best consumption obtained on alcohol was 2.52 pounds per brake horse-power hour.

CONCLUSIONS.

The following general conclusions are drawn as a result of the investigations reported in detail above:

1. Any gasoline engine of the ordinary types can be run on alcohol fuel without any material change in the construction of the engine. The only difficulties likely to be encountered are in starting and in supplying a sufficient quantity of fuel, a quantity which must be considerably greater than the quantity of gasoline required.

2. When an engine is run on alcohol, its operation is more noiseless than when run on gasoline, its maximum power is usually materially higher than it is on gasoline, and there is no danger of any injurious hammering with alcohol such as may occur with gasoline.

3. For automobile air cooled engines alcohol seems to be especially adapted as a fuel, since the temperature of the engine cylinder may rise much higher before auto-ignition takes place than is possible with gasoline fuel; and if auto-ignition of the alcohol fuel does occur no injurious hammering can result.

4. The consumption of fuel in pounds per brake horse-power, whether the fuel is gasoline or alcohol, depends chiefly upon the horse-power at which the engine is being run and upon the setting of the fuel supply valve. It is easily possible for the fuel consumption per horse-power hour to be increased to double the best value, either by running the engine on a load below its full power or by a poor setting of fuel supply valve.

5. The investigations also showed that the fuel consumption was affected by the time of ignition, by the speed, and by the initial compression of the fuel charge. No tests were made to determine the maximum possible change in fuel consumption that could be produced by changing the time of ignition, but when near the best fuel consumption it was shown to be important to have an early ignition. So far as tested, the alcohol fuel consumption was better at low than at high speeds. So far as investigated, increasing the initial compression from 70 to 125 pounds produced only a very slight improvement in the consumption of alcohol.

6. It is probable that for any given engine the fuel consumption is also affected by the quantity and temperature of cooling water used, and the nature of the cooling system, by the type of ignition apparatus, by the quantity and quality of lubricating oil, by the temperature and humidity of the atmosphere, and by the initial temperature of the fuel.

7. It seems probable that all well-constructed engines of the same size will have approximately the same fuel consumption when working under the most advantageous conditions.

8. With any good small stationary engine as small a fuel consumption as 0.70 pound of gasoline, or 1.16 pounds of alcohol, per brake horse-power hour may reasonably be expected under favorable conditions. These values correspond to 0.118 and 0.170 gallon, respectively, or 0.95 pint of gasoline, and 1.36 pints of alcohol. Based on the high calorific values of 21,120 B. T. U. per pound of gasoline and 11,880 per pound of alcohol, these consumptions represent thermal efficiencies of 17.2 per cent for gasoline and 18.5 per cent for alcohol. But calculated on the basis of the low calorific values of 19,660 B. T. U. per pound for gasoline and 10,620 for alcohol, the thermal efficiencies become 18.5 for the former fuel and 20.7 for alcohol. The ratio of the high calorific values used above is, alcohol to gasoline, 1.66 by weight, or 1.44 by volume.—Abstracted from Iron Age.

Recent railway legislation in Massachusetts requires every steam railroad in the State to install, subject to the approval of the Board of Railroad Commissioners, a spark arrester on every locomotive in which wood, coal or coke is burned. The commissioners are making determined efforts to protect woodlands near the railroads from fire. Efforts in spark arresting are almost as old as locomotives, but there is still room for ingenuity in this direction, and the subject is worthy the attention of inventors.

SHOOTING OIL WELLS.

A FEW days after a well is "drilled in," a charge of about 20 quarts of nitroglycerine is exploded in the sand for the purpose of increasing the flow of oil. Then, after several months, when the flow becomes sluggish or stops altogether, a charge of 40 quarts is used. This greatly enlarges the cavity in the sand at the bottom of the well. Other and larger charges are subsequently used if the condition of the well requires such treatment. The charge for the first shot is applied by putting the nitroglycerine in a tin tube and lowering it to the proper location in the oil sand. The tube is about 4½ inches in diameter and from 4 to 6 feet long. It has a conical bottom, to the apex of which is attached a piece of 2-inch tube, also made of tin. The length of this small tube is made to suit the conditions of the well, as shown by careful measurement, so that when the tube rests on the bottom of the well, the charge of nitroglycerine will be located at the proper height in the sand. Before introducing the shot, the well is cleaned out thoroughly with the sand bucket and a swab lowered the entire depth and drawn out. The depth is measured carefully with a steel tape having a weight or iron basket fastened to the end. The top of the tube containing the nitroglycerine for the first shot is fitted with a heavy metal disk and a fulminate cap. A heavy copper bale completes the arrangement. The bale is supported by a flat hook on a light cord that passes over a small pulley tied to the drill rod just over the well, and then to the reel clamped to the flywheel of the engine at the farther end of the rig. The tube is suspended in the well with the top at a convenient height above the floor of the derrick and the nitroglycerine is slowly and carefully poured into it from the two 2-gallon cans as they are brought from the wagon near by. The reel is then turned by hand and the charge slowly lowered to the bottom of the well. When the anchor tube attached to the lower end of the nitroglycerine tube bottoms, the slack in the cord loosens the hook, the clutch on the reel is set, and the engine is operated so as to rapidly wind up the cord. All boiler fires, if any near the well, are put out, and a 2-foot piece of 2-inch pipe called a "go devil," is dropped into the well. After waiting to hear the report of the explosion as transmitted instantly by the well casing, and thus being assured that it is a live shot, the "shooter" rapidly hunts a safe location with the other spectators to watch the results. After quite an appreciable time, which seems much longer to the spectators than it really is, a gradually increasing roar is heard, followed by a grand fountain display of gas, oil, and rocks, the latter making a noisy bombardment of the derrick. The oil often rises above an 80-foot derrick, and during the progress of the display the derrick is sometimes entirely hidden from view by the cloud of oil. It is a sight well worth going a long distance to witness. The pieces of rock from the Berea sand and the slate are usually small, though sometimes a rock as large as one's fist is forced out. In case it is not convenient to take the empty nitroglycerine cans back to the magazine for refilling, the shooter destroys them by means of a fuse and cap. The cans are piled up at some out-of-the-way place and exploded; the nitroglycerine adhering to the inner surface of the cans is powerful enough to annihilate the cans and make a good-sized excavation in the ground.

The subsequent shots are applied in a different manner, as the tube containing the charge will not stand vertical in the well, but drops into the cavity formed by the previous shot or shots at the bottom of the well. The nitroglycerine is poured into several tin tubes about 3 or 4 feet long. These have conical ends, and the top of each tube has a small nozzle for introducing the nitroglycerine, by the use of a funnel. Each tube has a copper bale at the top, and some of them have a bale also at the bottom. By this arrangement the tubes are lowered into the well in pairs, two being tied together by a short piece of twine extending from the top bale of the lower tube to the bottom bale of the upper tube. When filled, the nozzle is closed with a cork. The pairs of tubes lie in irregular positions in the cavity of the bottom of the well and it is not possible to fire the charge by dropping a "go devil" on a cap attached to the top of any of the tubes. Hence a square having a fuse is used for firing the charge. The construction of the squib is such that the fused cap is surrounded by the nitroglycerine and thus is in the best location to insure an explosion of the charge. The fuse is lighted with a match and the squib dropped into the well. An awl and a pair of pliers are the only tools needed for making a squib.

The demands on the services of a shooter are very spasmodic. Some days he is on the road from early till late, driving long distances between the oil fields in Ohio, West Virginia, and Pennsylvania, and shooting several wells. At other times there is no business. The charge for shooting wells is approximately $1 per quart of explosive used.—From Mines and Minerals.

THE DEVELOPMENT OF ARMORED WAR VESSELS.—XII.

ARMOR PLATING IN THE UNITED STATES.

BY J. H. MORRISON.

Continued from Supplement No. 1662, page 293.

FIRST AMERICAN IRONCLAD IN SERVICE.

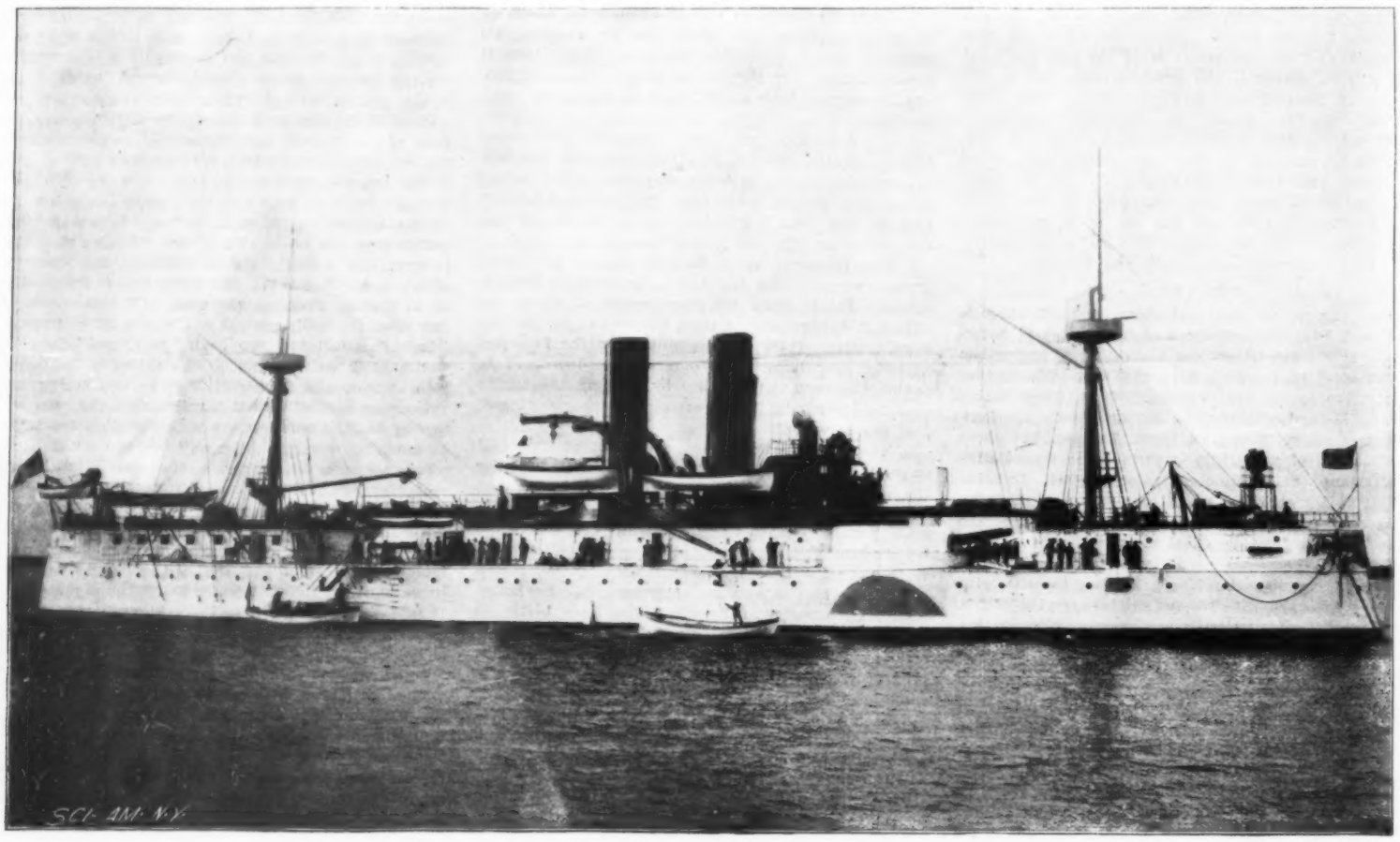
WHAT was the first ironclad vessel ready for service during the rebellion of 1861-1865 in the Union or Confederate navy?

It would seem from all the records available at this day of the building of these early ironclad or armored vessels, that the Confederate States Navy Department certainly made much progress under great difficulties, for they had no large machine shops, but one navy yard of any size, and no large number of skilled workmen, such as would be required for the work to be done. What labor they added was obtained from the Northern States under many inducements, while a few got through the lines in the blockade runners from Europe. The Secretary of the Confederate Navy had been on the Naval Committee in the United States Senate, and was as well posted on naval matters as any public man in this country at that day. This gave him a great advantage in the new field. His first recommendation for an ironclad war vessel was made to the Confederate Congress on May 8, 1861. This was but eighteen days after the Norfolk navy yard was burned, and the "Merrimac" at the same time. This vessel was floated and docked on May 30, and on June 10 work was commenced to prepare the way for the rebuilding of the vessel. Then there was the ram "Manassas," a rebuilt merchant vessel owned by private parties at New Orleans, commenced about May 15 and completed some time in August or September following. The Secretary of the Confederate Navy made the first contract for an ironclad vessel on August 24, 1861. She was built at Memphis, Tenn., and named "Arkansas." It will be noticed this contract was made seventeen days after the contract for the St. Louis boats was signed by J. B. Eads & Co. for the same general style of vessel, and for the western rivers. On September 18 he contracted for the "Louisiana," built at New Orleans, and on September 20 for the "Mississippi," constructed also at New Orleans. We thus see that in six months the Confederate States had four ironclad vessels under way, having decided on the type of vessel that would best serve their purpose for the western rivers, and could be built in the shortest time.

As to the Union Navy Department, they were not in the field at so early a day for ironclad vessels for the coast, for besides having many wooden-hull naval vessels, they were busy in equipping several merchant steam vessels that were altered into gunboats for the blockade service in a short time. Congress did not meet in extra session until July 4, 1861, and it was after this date before the Secretary of the Navy was authorized to contract for building ironclad vessels. The first official record that appears of ironclad steamers is a report of the Secretary of the Navy to Congress on July 4, 1861. We will bear in mind that the plans for the Eads gunboats were made in Washington before this time. Congress now directed that a board of naval officers be appointed to investigate the plans and specifications for construction of ironclad vessels, and appropriated $1,500,000 for the purpose. On September 16 this naval board reported on acceptance of plans that resulted in the building of the "Monitor," "New Ironsides," "Galena," and "Keokuk." These were the vessels built at first by the United States Navy Department on the Atlantic coast.

There were prior to this on the western rivers the seven wooden-hull ironclad gunboats, built some time before they began to wake up to the necessity of an ironclad fleet for the Atlantic coast. These were the gunboats built by James B. Eads & Co. for the War Department. The department advertised for bids in July, and a contract was made August 7, 1861. We thus see that these vessels were the first under construction for the Union cause, and in advance of any new ironclad vessels contracted for by the Confederate States Navy Department. The plans for these vessels were under consideration when the "Merrimac" was floated.

There is every indication that the plans for the reconstruction of the "Merrimac" had not been fully worked out at the time of the commencement of the St. Louis ironclads. There is no intention to discuss the question of the origin of the design of the reconstructed "Merrimac," that was the subject of such a bitter controversy in the Confederate States navy, and it was never fully settled, it seems, between the Confederate Naval Constructor John L. Porter and Commander J. M. Brooke, who was attached to the Navy Department at Richmond, Va., at the time. It may not be out of place to say that after a search of all the available information on the subject from those in a position to be advised on the origin of the design of the altered vessel, Commander Brooke as well as Constructor Porter each offered substantial evidence of being the main factor in the design of the rebuilt vessel, and the most impartial decision on the case at this day would seem to be that the honors of the design be divided between the contestants. The naval constructor, it would appear, should have more credit for the rebuilding of the vessel than has been generally given him. Commander Brooke obtained a patent from the Confederate Patent Office on July 29, 1862, for an ironclad vessel, in which he claims "that her bow and stern shall each extend under water beyond the forward and after ends of the shield, which protects the crew and guns, sufficiently to give the sharpness necessary to the attainment of high speed and the buoyancy to support the weight of iron applied without an inconvenient increase of draft." The "water-cladding" had been anticipated in the Stevens battery, and the "Merrimac" and the "Naugatuck" were the only vessels that were "waterclad" during the civil war.



THE UNITED STATES BATTLESHIP "MAINE," SUNK IN HAVANA HARBOR, 1898.

The course of reconstruction of the "Merrimac" would appear to be: After being placed in the drydock on May 30, 1861, work was begun in removing the burned portion of the hull and cutting her down to the gun deck. The rebuilding began in August, as the constructor has said, "the Norfolk navy yard was not used to any extent before July 1." The iron plating was commenced to be laid on the casemate or shield in November, while the ram was placed in position on the vessel in January, 1862, and the vessel floated from the drydock in the latter part of January or first part of February.

It is a matter of record that just after the St. Louis ironclad gunboats had been commenced, the Secretary of the Confederate Navy had mechanics sent to St. Louis to obtain the true character and progress of construction of these vessels, and who obtained employment upon them. If the details of these vessels were of moment prior to the making of a contract for one of the new vessels by the Confederate States Navy Department, it is altogether probable that the details of the "Merrimac" had not been fully worked out at the time. There is no doubt that what gave them the most concern was regarding the iron armor, for as

noted on previous pages, it was of the same general shape and sizes, but not so wide, as that rolled for the St. Louis gunboats. It was about three months after the sample plates for the Eads gunboats were the subject of experiments before the Atlanta Rolling Mill began to roll this heavy iron, and it is very doubtful if the Tredegar Iron Works began rolling the armor for the "Merrimac" prior to the time the Atlanta mill began operations on this class of work.

Leaving out of question the "Manassas," the St. Louis ironclads were the pioneer ironclad gunboats built for such in this country. It is acknowledged that they were but partially ironclad, and not built to battle from all sides of the vessel. The "Monitor" was the first *all iron* armored United States war vessel in service. The first seagoing ironclad war vessel of the United States navy was the "New Ironsides."

THE OLD AND THE NEW NAVY.

At the close of the civil war the work ceased on all unfinished armored and iron-hull vessels for the navy, and a course of economy in the construction of the naval vessels was laid out that was carried on for several years. The Annual Report of the Secretary of the Navy for 1866 shows that there were fifty-four ironclads of all rates laid up, and seven not completed. There were five iron-hull vessels, not ironclad, at the same time on the Navy Register, as well as a few with steel hulls that were captured blockade runners. The only iron-hull vessels built for the United States navy from the ending of the rebellion to the recommendations made in 1881 for a new navy by Secretary Hunt were the three unarmored sloops of war, the "Alert," "Huron," and the "Ranger" in 1873, and the ram torpedo boats "Alarm" and "Intrepid" in 1875. These sloops of war were built in response to a demand for some progress in the character of our naval vessels, and at the same time to give encouragement to the iron shipbuilding industry of the country. These vessels were built at private shipyards during a period of great stagnation in the industries of the country. This was the period when the iron-hull vessel fitted with the compound engine was receiving much attention for new vessels building for the merchant marine, on account of the vessels' comparatively large carrying capacity and economy of this type of engine.

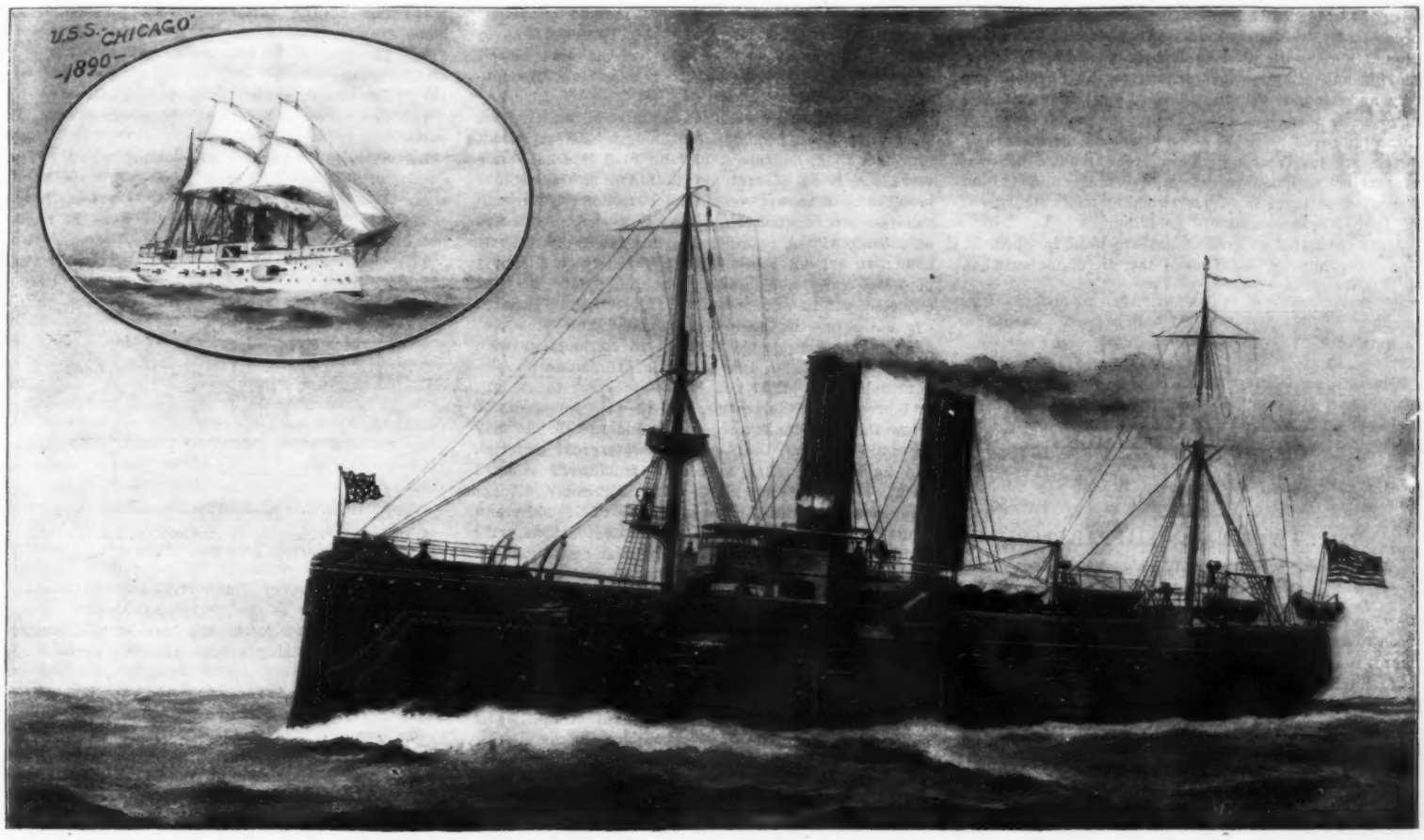
It was in 1871 that the "establishing iron shipbuilding yards and docks to economize expenditure in the navy, and to aid in restoring commerce," was first brought to the attention of Congress by the Secretary of the Navy. This was a proposition of the International Steamship Company to establish a plant on the Atlantic coast, where they would have their rolling mills, foundry, shipyard, and machine shops, for the construction of iron vessels and their machinery complete, within their own works. The government was not required to invest any capital in the enterprise, but to act as a trustee, and would have a preference in case of the want of any work of necessity. No action appears to have been taken in the matter beyond a very favorable report being made. It was during this year that the Chief of the Engineering Bureau, J. W. King, was sent to Europe to obtain such data as were available, of the most modern-built naval vessels of the European navies, that we might be in a position to take advantage of all the experiments and improvements that science had suggested, to build up and strengthen our own navy, by the addition of an improved class of vessels. There was much information laid before the department in this report, but Congress does not appear to have been stirred to any action at the time in the matter. They held the purse strings of the Treasury closed against any expenditures for the development of a new iron-hull navy at that time.

Of the condition of our ironclad fleet in 1874, it is found in the Annual Report of that year, "of the forty-eight so-called ironclads now on the Navy Register, thirty-one can never be of the least use in peace or war, unless sunk as obstructions to channels."

The same lack of desire to adopt the iron-armored vessel, of the type building by the European naval powers, is expressed in 1876 by the Secretary of the Navy: "The question of what should compose a sound and economical but efficient naval force has presented during the last few years so many different aspects, that we may congratulate ourselves that we have not followed step by step in the practical but expensive development of the problem, in which other maritime nations have been engaged. The question constantly recurs, however, brought up by conflicting interests and opinions, Shall we enter upon the expensive and unsatisfactory construction of armor-plated, gun-bearing vessels, involving millions of dollars in the cost of each one? Or shall we be content with providing ourselves, at a minimum cost, with the means of destroying such vessels, should they appear in hostile attitude on our coasts or in our bays or harbors?" He then advocates building fast, well-built wooden cruisers, capable of destroying an enemy's commerce in time of war; the monitor class of vessels to be used in conjunction with the other forces, and the use of torpedo boats. He especially recommended the building of the marine ram, which was thought to be a weapon of most destructive warfare. He further said on the subject: "I think we may well dispense, for the present at least, with the heavy-armored and unwieldy ironclads of European nations, and also with the monster cannon necessary to penetrate them. Any vessel which can safely cross the seas to enter our harbors, or to lie upon our shores, will be found vulnerable to cannon of moderate weight and caliber, while the heaviest armor will not protect a ship from the attacks of torpedoes managed by brave and well-instructed officers. Thus our monitor system supported by the marine ram, commanded by enterprising officers, and reinforced by the deadly torpedo in skillful and scientific hands, will, I think, supply all that is absolutely necessary for the naval share of our coast defense, and will be found efficient for our purposes against any foreign ironclads which can reach our coasts or enter our harbors. With these we may rest content for the present; but it must be understood that the navy in all its efficient elements is in a constant state of transition and progression, and can only be kept efficient by seizing, experimenting upon, and developing in the quiet times of peace each new principle of warlike progress as it arises."

The refusal of Congress for so many years to make appropriations for the building of a modern navy has been noted by many able writers on the development of our navy; but there is one side of the question that has not been touched on, that may have been, and probably was, a factor of no small moment in the case, and that had much influence in deferring the change to iron-hull vessels. That was the political side. It had been an unwritten law of politics for many years that our navy yards should be one of the recruiting agencies of the political party in power, and it was always taken advantage of and worked to its fullest extent. So when the wooden-hull naval vessels became obsolete, Congress refused to appropriate money for the construction of new wooden vessels; and for the Navy Department to keep the men employed it was necessary "to repair" the old vessels. Besides, there were also the contracts made for refurnishing and refitting these vessels in all their departments, that was a lever of immense political power at the time. As the government had no iron-shipbuilding plants at any of the navy yards at the time, all iron-hull vessels would necessarily have to be built at the private shipbuilding yards. That would never do from a political standpoint, as so many men must necessarily be suspended at the navy yards for want of work, if a new iron-hull navy was placed under construction at private shipbuilding yards. It has been done later, and successfully, too. There have been radical changes made since that period in the management of our navy yards, that are for the better interests of the department in every way, though open to great improvement at this day.

Matters affecting our navy drifted along with the same controlling policy until 1881, when Secretary W. H. Hunt, on June 29 of that year, took the first step in reconstructing the navy, and appointed an advisory board composed of fifteen officers of the navy from the several branches of the naval service. This action of Naval Secretary Hunt should be noted as the opening of a new era in our naval affairs. It seems to have escaped notice as the first official action taken toward the building of our new navy. This advisory board was formed to consider and advise the department upon the following subjects: The number of vessels that should now be built. Their class, size, and displacement. The material and form of their



THE RECONSTRUCTED CRUISER "CHICAGO."

construction. The nature and size of the engines and machinery required for each. The ordnance and armament necessary for each. The appropriate equipments and rigging of each. The internal arrangements of each; and upon such other details as may seem to be necessary and proper, and lastly, the probable cost of the whole of each vessel when complete and ready for service.

This board reported to the Navy Department in November following, but only unarmored vessels were considered and reported upon at the time, as "the order explicitly stated that the necessities of the present time were to be provided for." These recommendations were laid before Congress, but there was no appropriation made for the increase of the navy at that session of Congress, as the bill for its relief contained some radical provisions that prevented its passage. The second Naval Advisory Board, consisting of five naval officers and two civilian experts, created through an act of Congress, was organized in November, 1882, and in May following recommended the building of the three cruisers, the "Chicago," the "Atlanta," the "Boston," and the dispatch boat "Dolphin." The "Chicago" was a steel twin-screw, coal-protected cruiser, having a steel protective deck 1½ inches thick on the flat, 1 foot above load waterline, and 12 feet from the side it was bent downward toward the hull. The "coal armor" was about 9 feet in thickness, and was located just above the curved portion of the protective deck. The turrets were unarmored. The only protection for the men operating the guns was afforded by steel shields placed on the guns. The "Boston" and the "Atlanta" were each single-screw vessels of steel, having a protective steel deck 1½ inches thick covering the machinery and boiler spaces, and having a coal armor nearly the same as in the "Chicago." The main-deck structure, covering the main battery of the vessel, was plated with ¾-inch steel, and the open guns fore and aft on main deck were protected by an armored mantlet as protection from machine guns. The "Dolphin" is a single-screw vessel of steel also. As the governing condition in the design of this vessel was for high speed to be maintained for several days, there was no attempt whatever made at protection of the vessel. She may be said to be on the design of a high-speed merchant vessel.

At the commencement of the building of these vessels, it was found that the steel manufacturers were unable to fill the orders for the structural material until they had made extensive additions to their plants in many instances. They were not as well prepared for the work as they had supposed. The large sizes of shapes, and the heavy plating required, with the stringent requirements of the contracts in the quality of the material, etc., created some delay in the delivery. They were unable at first to produce a uniform grade of steel of contract demands, but experience soon overcame the difficulty. The limited experience of the inspectors, with their very rigid inspections of the material for the Navy Department, was an additional cause of delay. It was new work for the steel manufacturers as well as the inspectors.

(To be continued.)

DUST PREVENTION IN THE GRINDING TRADES.

SOME IMPROVED METHODS.

BY SAMUEL R. BENNETT, M.A.

IN the course of an investigation carried out by the order of Dr. Whitelegge, Chief Inspector of Factories, Home Office, with a view to devising methods of removing and allaying dust arising in the Sheffield cutlery and kindred grinding trades, some improvements have been made on the existing methods. Two of these improved methods are noteworthy, because their effects are far reaching. They are (1) a wet method of "racing" grindstones when first hung, and (2) an improved form of hood for catching dust, etc., given off in the processes of dry grinding.

Many varieties of grindstones are used in Sheffield. Some are huge masses, seven feet in diameter when

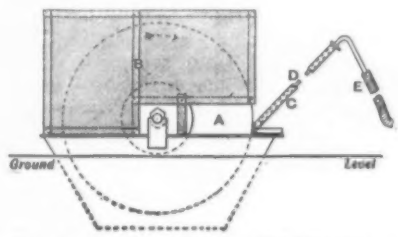


FIG. 1.—WET RACING APPARATUS.

A. Grindstone. B. Splash box. C. Racing pipe. D. Inner tube. E. Flexible hose (to water tap).

new and twelve inches or more in thickness, and are used in saw-grinding, etc. Others are used when little more than seven inches in diameter and one inch across. Some are almost of a flinty hardness, while others could almost be crumbled in the hands.

The troughs in which the stones revolve are sunk into the floor so that approximately three-fifths of the stone is above the floor level, allowing for the spindle bearings over the trough. All stones are hung on spindles and centered thereon. This centering, when the stones are small, is done by means of wedges between the spindles and the central holes in the stones. For almost all wet stones above twelve inches in diameter circular side-plates are used. These are screwed up against the sides, after the rough quarried stones have been approximately balanced on the axles. The remaining irregularities, chisel-marks, eccentricities, etc., from the true cylinder, are removed by the process of "racing." To perform this operation the grinder places a short piece of wooden plank close to the face of the slowly revolving stone. Using an iron or steel rod pointed at the end as a lever he firmly holds the point against the stone; thus the projecting parts of stone are broken away. By rolling the lever on the plank the whole face of the stone is trued up. The sides are then similarly dealt with.

Up to the present time racing has been done with the stone and apparatus in a dry state. Any person who has been in a grinding hull or room while dry racing was being done will have experienced the suffocating clouds of swirling dust which penetrate to every corner. The dust is almost wholly siliceous, and has an irritant effect on the nostrils and throat. It covers thickly everything and everybody in the hull. Much remains suspended in the air for over an hour after the racing is finished. The baneful effect on the lungs of the grinders is easily understood.

Mr. C. F. R. Johnston, H.M. Inspector of Factories, and the writer tried many kinds of apparatus—some ingenious, some expensive, most of them cumbersome—for racing a grindstone without making much dust. We found none that came within our requirements. At length we devised the following method which has the merits of being effective and cheap, and has in addition the great boon of allaying the dust almost or quite completely—a boon to grinders and machinery owners alike.

The apparatus consists essentially of an iron or steel pipe of any convenient dimensions (say, about four feet long, and about half an inch internal diameter). A piece of ordinary half-inch gas-piping has been found to answer well. Almost completely through this pipe one of smaller diameter is passed. By means of a bend, swivel, or otherwise this inner pipe is connected to a flexible hose-pipe through which a supply of water can be obtained. The inner pipe may be adjusted within and prevented from slipping through the outer one by means of a collar and set-screw, sleeve, or other simple device. In conjunction with this pipe is used a box over the grindstone, to prevent splashing. This box is preferably of the length and breadth of the trough, and of such height as to allow the stone to revolve freely underneath. It may be made of wood, iron, or other waterproof material. We have found that a wooden framework covered with waterproof oiled cloth suited admirably. About nine inches deep of the lower portion of the sides and end of the box are cut away opposite to those parts of the face and sides of the grindstone where the racing tool is to be used, and to allow for the axle and bearings. It can be supported in any convenient way to make up for this.

Racing is performed with the gas-pipe in a similar manner to that with the ordinary racing steel. A jet of water passing through the inner pipe splashes on the stone and mixes intimately with the stone dust immediately on disintegration. The amount of this water supply depends on the size and quality of the stone—a rate of a little less than one gallon per minute has been found sufficient for a stone nearly four feet in diameter, of moderate hardness.

The accompanying figure will explain the appliance.

When a grinding stone revolves with a high angular velocity a considerable whirl is produced by friction with the air in the immediate neighborhood of the stone's periphery. If an article be pressed on its surface whereby particles of the stone and of the article are disintegrated, it will be found that the heaviest particles fly off in or near the direction of the tangent to the wheel at the grinding points. As we proceed from this tangent in the direction in which the stone is revolving, the particles get finer until some of the finest particles are carried right round the wheel by the whirl produced by the periphery of the stone. The behavior of these particles varies according to their mass, density, the speed at which they are thrown off, and the neighborhood of interfering objects or forces. To consider this behavior the whole spray of particles may be divided into four classes:

1. The heaviest, which fly nearly in straight lines for some distance, and then fall to the ground.

2. Those whose initial velocity diminishes rapidly, float about for a short time, and then settle down near the stone.

3. The lightest, which swirl from the peripheral current and float about, wafted by every eddy all over the room in which the grinding is done.

4. Those which are carried completely round the stone, and impinge again on the body or hands of the grinder, or on the article ground.

The proportions of each of these four classes in any particular case depend on:

(*a*) Position, nature, size, shape, and speed of the stone.

(*b*) The nature, variety and size of the articles being ground.

(*c*) The amount of movement and pressure of the article on the stone.

(*d*) The situation of neighboring objects.

(*e*) The currents of air in the room affecting the particles.

Perfect ventilation is only secured when all four classes of particles are carried away, throughout every stage of the stone's wear. This must be done in such a manner that the progress of the work in hand is not impeded by reason of—

(1.) Obstruction of free movement of the grinder.

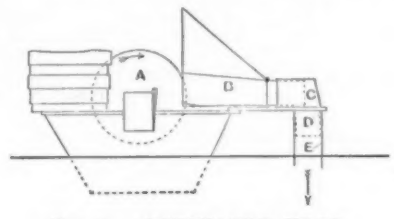


FIG. 2.—ADJUSTABLE HOOD.

A. Grindstone. B. Adjustable part of hood. C. Fixed part of hood. D. Adapter to fan pipe. E. Fan pipe.

(2.) Obstruction of free movement of the article being ground.

(3.) Interference with the grinder's clear view owing to the lighting of the grinding surface being cut off.

(4.) Difficulty of removing the appliances fitted round the stone, to attend to it keeping in condition.

These four sets of conditions have to be satisfied in general, and in particular when the effective ventilation of any stone is being considered. The relative importance of the various conditions depends on the trades considered. In some trades the question of lighting is of prime importance, in others, of secondary, as the sparks generated by the grinding illuminate the stones sufficiently.

The removal of metallic and siliceous dust produced in quantity by rapidly revolving wheels or grindstones in the processes of grinding and glazing has always been deemed necessary for the good health of workers in these processes and those working in the same rooms. To effect such removal centrifugal fans have been almost invariably used, with ducts sucking air from the neighborhood of the stones or wheels. Many fan plants have failed completely because, relying on the analogy of gaseous fumes, the installers have attempted to deflect the heavy dust particles by the air-suction current alone.

Observation of the actual processes, and consideration of the *vis viva* of the particles thrown off, have led to the conclusion that owing to the high initial velocity of the particles, approximating in most cases to a mile a minute, it is impossible effectually to remove dust so generated by the deflecting power of an air current alone. In other words, it is necessary to catch the flying particles, to destroy to a large extent their initial velocity, and then to deal with them by the air current. The larger the particles given off in grinding the greater the force with which this principle must be applied. This general principle, obvious when demonstrated mathematically, was, I believe, first enunciated in a practical manner quite recently by Mr. H. H. Cunynghame, C.B., a member of the Council of the Society of Arts. One is almost forced to conclude that this principle has been un-

known to all, or certainly to the great majority of ventilating engineers, judging from the construction of the plants installed. As a rule attempts have been made to catch one or two of the four classes of particles, usually the first two. In order effectively to remove these without obstructing the lighting of the grinding surface, the hood fitted to the extremity of a fan-duct opposite a stone has been placed at a comparatively great distance. Thus the third class of dust is only partially deflected, while the fourth is left unaffected. The consequence is that the most deleterious dust is left to be inhaled by the workers.

Again, sometimes the hood is fixed so as to intercept classes 2 and 3, leaving classes 1 and 4 in the working room.

In no case has a hood capable of adjustment so as to intercept the fourth class been fitted, allowing at the same time of the grinding surface being illuminated.

Founded on the foregoing considerations, the following novel form of hood for dry grinding of razors, scissors, forks, augers, gimlets, etc., was devised by Mr. Johnston and the writer. It has been tried and found effective in many instances.

It consists of a board or plate having a hole at one end, and means of connecting this aperture so as to form an air-tight joint to the fan-duct. Over this aperture is fixed a pipe of slightly larger area than the air duct. Into this slides a similar pipe on to which a suitably shaped hood is fitted. This hood, which may have its top and sides constructed with glass panes to allow light to pass to the grinding surface, is kept with its lower edge close to the stone, and preferably overlaps the stone on either side. The device depends for its efficacy on the following points of construction:

First the height of the opening is such that the upper edge is above the tangent to the stone at the furthest backpoint on the stone at which grinding may be done, thus catching class 1 dust; second, the width is the minimum consistent with the width of the stone and the extent to which dust is ejected sideways by oblique grinding; third, the slope of top and sides is allowed for, so that all particles shall strike the hood at an oblique angle and be reflected further into the hood; fourth, the bottom comes close up to the stone, thus deflecting the air and fine dust whirl of the stone periphery and sides toward the duct; fifth, the top and sides may be constructed of easily removable strong sheet glass, insuring translucency, with wire netting on each side to prevent fracture; sixth, as the stone wears down, the hood can be drawn forward so as to intercept class 4 dust throughout the stone's wear; seventh, the hood may be made capable of a second adjustment on the fan duct; the top of the hood may have hinges at its juncture with the sliding pipe, and so be raised or lowered as the size of the stone requires.

The accompanying figure (Fig. 2) will illustrate the appliance.—Journal of the Society of Arts.

THE FORGING OF ALLOY STEELS.*

THE METALLURGY OF THE NEWER ALLOYS.

BY E. F. LAKE.

THE alloyed steels, such as nickel, chromium, vanadium, silicon, tungsten, and several other alloys as well as different combinations of these, are coming into more general use every day for the parts of high-grade machinery which are subjected to a high rate of wear, which have to support a great weight or which are subject to excessive strains, stresses, and vibration.

Many of the parts for which these alloyed steels are used are too intricate in form to use the regular rolling-mill shapes and the alloyed steels have not, as yet, been cast successfully, except in a few instances.

For these parts which cannot be produced from the rolling-mill shapes, or made in castings, forging is resorted to, and there are several different ways of turning out these forgings: by hand, under a steam hammer, in a hydraulic press, or in a drop-forging press.

When small pieces and but few of a kind are wanted, hand forging is undoubtedly the cheapest; but for large pieces, or where a large quantity is wanted, hand forging is the most expensive way of producing them and the strength is not apt to be as great as by any of the other methods. With a blacksmith shop properly equipped, a skilled smith can make forgings that are stronger than a rolled bar from the same ingot. To do this it must be hammered between the proper temperatures, which vary with different alloys of steel.

A nickel-chrome steel must be kept at 2,200 deg. F., which is a bright yellow color, all through the forging operations, while some of the carbon steels, particularly those that are high in carbon, cannot be heated to a temperature over 1,800 deg. F. without burning the metal; and when once burned it cannot be returned to its former state without remelting. The higher the carbon content the more danger there is of burning, and a steel of 1 per cent of carbon is very difficult to forge at all owing to the extremely low temperature at which it must be worked. The smith must also regulate the weight and effect of the blows so that it will be finished just as it reaches a blue heat. This will prevent the formation of large crystals, give the piece a dense, homogeneous grain with the atoms holding together by a high cohesive force and result in the steel having an increased strength.

In many of the more intricate shapes that are hand forged, recourse is had to welding, and if the average smith were told that he could not make a perfect weld, he would feel greatly insulted. But from a large number of so-called perfect welds that were examined very few showed a strength equal to 50 per cent of the unwelded section. With the alloy steels it is difficult to get a weld that will even show that percentage, as nickel, chromium, vanadium, tungsten, aluminium, and some other alloys do not lend themselves to the welding process.

Carbon, however, is the principal enemy of welds and with this as low as 0.15 per cent it must be handled with great care at the welding heat, while with 0.20 per cent of carbon the steel is very unreliable and with 0.50 per cent of carbon the steel is liable to be burnt at a temperature well below the welding heat.

Thus to make hand forgings where welds are necessary the pieces must be from two to three times the size of that necessary for the required strength and with some of the alloyed steel even this will not suffice.

Where electric or acetylene blowpipe welding is resorted to these bad features are overcome to a great extent and stronger welds are secured, as these methods melt the metal, allowing it to run together and then solidify, thus making a more perfect joint.

The steel which is the best adapted for forging under the hammer has about the following composition: Carbon, 0.15 per cent; silicon, 0.20 per cent; manganese, 0.52 per cent; phosphorus, 0.06 per cent; sulphur, 0.04 per cent.

This steel in the annealed state will show the following physical characteristics: Tensile strength, 55,000 pounds per square inch; elastic limit, 30,000 pounds per square inch; elongation in 8 inches, 29 per cent; reduction of area, 60 per cent.

When fractured it will show a silky fiber.

But for many purposes a steel of much greater strength than this must be hand-forged and then it becomes necessary for the smith to understand the nature of its component parts so he can forge it successfully, as many of the high-grade alloy steels can be rendered no better or stronger than the ordinary carbon steels by over or under heating and poor workmanship.

In many cases welds are absolutely necessary to produce the required shapes and a steel of the following composition is the best suitable for welding: Carbon, 0.08 per cent; silicon, 0.035 per cent; manganese, 0.110 per cent; phosphorus, 0.012 per cent; sulphur, 0.007 per cent.

In the annealed state it should show the following physical characteristics: Tensile strength, 48,000 pounds per square inch; elastic limit, 25,000 pounds per square inch; elongation in 2 inches, 27 per cent; reduction of area, 69 per cent.

For such work, however, a nickel steel casting that is much cheaper than forging is being produced by one foundry that shows the following physical characteristics: Tensile strength, 78,000 pounds per square inch; elastic limit, 50,000 pounds per square inch; elongation in 2 inches, 25 per cent; reduction of area, 42 per cent.

Direct steel castings are being turned out by several foundries that show the following physical characteristics: Tensile strength, 70,000 pounds per square inch; elastic limit, 35,000 pounds per square inch; elongation in 2 inches, 25 per cent; reduction of area, 40 per cent.

These steel castings can be forged, welded, bent cold, tempered, and in fact worked about the same as rolled steel. The nickel-steel castings can also be case-hardened, and are successfully used in place of forgings.

For pieces of considerable size and bulk the steam hammer is substituted for the hand-forging process. In this method of forging the hammer should be of a size to suit the size of the work. The hammerman must exercise a good deal of skill and judgment as to the power and speed of the blows delivered to the piece, as a too powerful blow will crush it and in the case of a high percentage of nickel, fissures and cracks are liable to develop which it will be difficult to get out, and which may show in the finished product.

This is especially true if the piece is allowed to fall below the forging temperature, or if the blows are not distributed evenly. If the blows are from a light trip-hammer, delivered at high speed, only the surface of the metal will be bruised and the core not affected, thus causing the core to be coarse-grained without the proper adhesion to insure the necessary strength.

A heavy hammer descending on the work at a slow speed will penetrate the mass to the center and allow the particles of metal to flow to their proper position and insure a fine grain of even texture and be uniform throughout its entire size.

* Abstracted from the American Machinist.

Cleaning of Alabaster.—To clean alabaster and remove spots of grease or tallow, it is usually sufficient to rub with powdered talc. Other methods are: (1) Immerse the objects in a solution of water and lime. (2) Benzine may also be employed, but it should be chemically pure. In this case the pieces should not be immersed, but washed with a cloth.

TIMBER AND ITS PROTECTION FROM MARINE ENEMIES.

A RECENTLY published volume of the Transactions of the Royal Society of New South Wales contains a valuable contribution on the subject, as regards that state, of the metallic protection of timber exposed to the attacks of the teredo, from the pen of Mr. H. D. Walsh, M. Inst. C. E., engineer-in-chief to the Sydney Harbor Board. The marine enemies of the timber pile are the teredo, the *Limnoria terebans*, and the *Sphæroma*. The teredo infesting Australian waters is not the same as that found in Europe. It attains a considerable size, and has been taken from one of the northern rivers of New South Wales as long as 6 feet and nearly ¾ inch in diameter. Its action is much more rapid than any other of the tribe, and it easily and quickly riddles timber of the density of ironbark, which has a specific gravity of 1.3. In fact, turpentine is the only Australian timber which the teredo dislikes, and this is on account of its nature, and not of its hardness, for it is one of the weakest of the native woods. The limnoria are small worms about the size of a grain of rice, which attack only the comparatively soft woods, and they cause a very minute honeycomb, so that they do not cause much serious difficulty. The sphœroma are larger, but their mode of attack is different, as they erode the surface, and they are often the means of disclosing the internal ravages of the teredo, as the hole made by the latter is very small near the surface, increasing with penetration. In the earlier works, turpentine wood was largely used owing to its immunity, and piles of this material have been recently drawn, to make way for larger and heavier construction, which are perfectly sound after thirty to forty years' immersion, and in many cases they have been used for other purposes.

Owing, however, to the quantity of the weaker piles required, and their extra bracing, etc., to obtain the requisite strength, ironbark piles sheathed with yellow metal have been of late years preferred, and the durability of the sheathing used in the older works seemed to support this view. Ironbark piles protected by Muntz metal have been in use forty-eight years and are practically sound; in fact they have been driven again in a new wharf. The protecting metal was worn slightly, but was sound, fairly flexible, and polished brightly, and there are other instances in coast works where the Muntz metal has been in good condition for over twenty-five years. Within the last few years, however, the metal supplied has been found to decay more rapidly; investigations were set on foot to ascertain the cause, and as the zinc disappears, leaving a brittle cellular copper skeleton, it is suggested that the modern electrolytic process in the production of copper, whereby chemically pure copper is attained, may have something to do with rapid corrosion. Advices from England recommend that navy brass, manufactured by the Muntz firm at a slightly greater cost, should be used. This has an addition of about 1 per cent of tin to the ordinary yellow metal, but there has not been sufficient experience of this expedient to test its sufficiency. The coating of the metal inside with coal tar has been found to protect it from corrosion set up by juices from the wood.

Unless the sheathing can be restored to its former efficiency either concrete building must be adopted or turpentine timber, calling for a great bulk of material on account of its weakness, must be used.

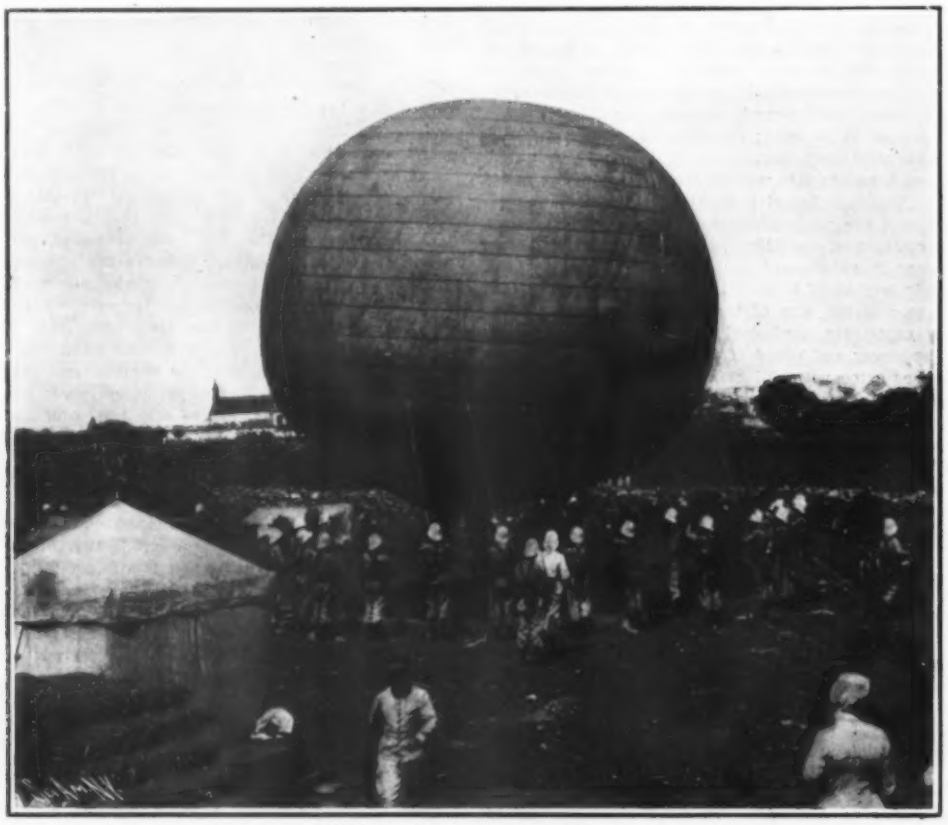
THE FRENCH CAPTIVE WAR BALLOON.

ITS USE AT CASABLANCA.

THE French are making use of captive balloons in their operations in Morocco. They have a wholesome dread of any of their men falling into the hands of the Moors, and a captive balloon acts as the "eyes" of the army in lieu of scouts. In the rough, low-lying, but undulating country round Casablanca it is easy for bodies of men to move without being seen by watchers on the ground, but the captive balloon searches the hidden valleys and signals the news to the French general. Many French sorties are made at daybreak. The balloon is sent up, and by the time the expeditionary force has wound through the intricate wire entanglements that surround their camp the balloon has located the enemy and indicated the direction of the march. The Arabs, as the Moors are called by the French, have no uncertain opinion of the balloon; they believe it is a special invention of the powers of darkness.

The French—pioneers in aeronautics—made use of balloons in 1871. When Paris was besieged balloons were sent up and a fitful intercourse kept with the outside world. It was a risky business in those days; the balloon and its crew might fall on friendly soil, or might drop into the hands of the Germans. Science has progressed since 1871. To-day the French general is in direct touch, by wireless telegraphy, with Paris.

THE FRENCH FOREIGN LEGION ARE INTERESTED SPECTATORS.



GETTING READY FOR AN ASCENT.

THE BALLOON IN WARFARE.

THE INJURIOUS EFFECTS OF LIGHT UPON THE EYE.

By DR. A. BIRCH-HIRSCHFELD.

THAT strong light may injure the eye has probably been known from remote antiquity. Even a brief glance at the sun may permanently affect the sight. On coming into broad daylight after a long sojourn in a dark room we feel pain in the eyes and involuntarily close them, and eyes accustomed to diffused daylight are similarly affected by looking long at the sunlit surface of snow or water or at bright artificial lights.

Two distinct varieties of partial blindness are caused by exposure to light, one by luminous, the other by ultraviolet rays. The type of the first variety is the sun blindness which is produced by looking at the sun with the naked eye. Many such cases occur at every solar eclipse and Galileo's blindness has been attributed to his observation of sun spots.

The symptoms of sun blindness are very characteristic. Soon after the exposure the sufferer notices that objects which are looked at directly are indistinct, veiled or quite invisible, while the rest of the field of view appears as usual. On looking at a white surface he sees a dark spot surrounded by a shimmer.

In mild cases the ophthalmoscope reveals no change, but in severe cases a pale gray circle fringed with pigment cells is found in the place of the "yellow spot" in the center of the retina. In many cases the sight gradually improves, but as a rule it remains permanently more or less impaired, and total blindness sometimes results.

My experiments on animals show a progressive lesion of the retina, beginning with the superficial layer, and consisting of œdema, exudation of fluid, and atrophy of the nervous tissue, due to disturbances of circulation in the choroid and retina.

Sun blindness is evidently caused by the luminous rays. Sunlight, except on high mountains, contains few ultraviolet rays and these are largely absorbed by the lens and humors of the eye. In animals the symptoms can be produced by luminous rays alone but not by ultraviolet rays alone. Ultraviolet rays cause blindness of a different character.

Slight sun blindness caused by reflected sunlight is of common occurrence. There is no serious impairment of vision but the eyes are abnormally sensitive and there is a feeling of fatigue and pain. Individual differences in quantity of pigment and size of pupil here come into play and general bodily weakness may so affect the retina that it is injured by an illumination that is harmless to a normal eye.

Night blindness is a peculiar condition which is caused partly but not wholly by exposure to light. The patient sees very well in strong illumination but cannot detect slight differences of shade in a dim light. The same condition occurs, transiently, in normal persons on going from a highly lighted room to a dark street. Night blindness is usually epidemic and chiefly affects young persons who are overworked and insufficiently nourished. It is very common among the Russian peasantry after the rigid Lenten fast, and Vaucel tells of a French garrison town where a search party was sent out every evening to bring in soldiers who were helpless after nightfall.

The explanation of night blindness is that the visual purple, which gives the retinal rods sensitiveness for very weak light, has been bleached and destroyed by light and has not been restored, owing to malnutrition. Practically, it is found that attention must be given to the general health. Cod liver oil is said to be very beneficial, and in many parts of Russia it is known as "oil for blindness."

We come now to the effects produced on the eye by ultra-violet rays. The crystalline lens strongly absorbs these rays, and thus partially protects the retina from their action. An eye from which the lens has been removed (in cataract or extreme myopia) is far more sensitive than a normal eye to ultra-violet rays. Glass also absorbs these rays—a fact of great practical importance—and so, to a great extent, do the lower strata of the atmosphere. Injury to the eyes due to ultra-violet solar radiation, therefore, occurs chiefly at great altitudes.

In comparison with sunlight, the radiations emitted by the electric arc, the electric spark, the magnesium light, and the mercury vapor lamp contain a very large proportion of ultra-violet rays.

The injuries caused by ultra-violet rays include snow blindness, electric light blindness, lightning blindness, and erythropsia or "seeing red."

Medical records contain few cases of severe snow blindness, but the less serious and unrecorded cases must be far more numerous. It is most likely to occur at high altitudes where, as we have seen, sunlight is rich in ultra-violet rays. The principal symptom is a violent inflammation of the conjunctiva, cornea, and iris, often accompanied by aversion to light, tears, cramp in the eyelids, and intense pain. In severe cases the cornea ulcerates. Disturbance of vision often occurs. Reich, who studied seventy-three cases in the Caucasus, found the retina and optic nerve congested with blood.

The effects produced by powerful electric lights are very similar to the above. Little discomfort is felt at first, but after a while all objects appear red, and six or eight hours after the exposure the conjunctiva becomes red, swollen, and inflamed. The pain increases, and the sufferer feels as if grains of sharp sand were rubbed under the eyelids. These symptoms abate in the course of days or weeks, but the partial blindness persists much longer, and in some cases through life. Terrien, in his examination of forty-five cases, found that in many the retina and optic nerve were greatly inflamed, while in others their appearance remained normal, although the sight was greatly injured. In no case did he find the circumscribed blind area which characterizes sun blindness.

As lightning is an electric spark of great intensity and peculiarly rich in ultra-violet rays, we should expect its effects to be similar to those of the electric light. A discrimination must be made, however, between true lightning blindness and direct injury to the eye by a stroke of lightning. The former is exactly similar to electric light blindness, but the turbidity of the lens and the profound inflammatory changes in the choroid that sometimes lead to complete atrophy of the optic nerve must be attributed chiefly to the direct mechanical and electrolytic action of the discharge, rather than to the ultra-violet rays of the flash.

A fourth effect of exposure to ultra-violet light is the condition known as erythropsia, in which all objects appear red. It occurs as the first symptom of electric light blindness, and also in other cases. Tourists who arrive at an Alpine shelter after a long tramp over snow and ice are often surprised to find that all light-colored objects look red to them. The condition is transitory and the sight is not injured. Fuchs, who produced the phenomenon repeatedly in himself, explained it by assuming that the visual purple of the retina was greatly reduced by the prolonged action of the ultra-violet rays of sunlight at great altitudes, and that the entrance into the hut was immediately followed by a rapid formation of a layer of fresh visual purple over the retina. But the center of the retina (the yellow spot) contains no visual purple, and yet erythropsia can be produced in an eye of which all except the central portion is protected by a screen. It is noteworthy that eyes from which the lenses have been removed are particularly susceptible to erythropsia.

The differences between sun blindness, on the one hand, and snow blindness, electric light blindness, and lightning blindness, on the other hand, are very clearly marked. In addition to differences in the disturbance of vision, sun blindness is characterized by the limitation of the effect to a small central area of the retina and by absence of the serious inflammation of the front of the eye, the erythropsia and the long interval between exposure and effect that occur in the other three forms, all caused by ultra-violet rays, as Midmark has proved by experiment.

I have discovered some other interesting facts by employing modern methods of staining nerve cells after exposing the eye to ultra-violet light. The nerve cells of the retina, like those of the brain and spinal cord, contain a granular and scaly deposit, known as the "chromatic substance," or chromatin, which takes a deep stain from certain dyes. In the normal retina these grains and scales are regularly arranged and sharply bounded. They appear with especial distinctness and abundance in the retina of an eye that has long been kept in darkness. The quantity of chromatin is diminished by exposure to bright daylight, and far more rapidly by exposure to light which contains a large proportion of ultra-violet rays.

The normal chromatin structure is regained in the course of a few days, but exposure to intense ultra-violet radiation causes the nerve cells to wither and disintegrate, and permanent injury results. The effect of ultra-violet rays is distributed over the entire retina and is most marked in its inner layers, while the atrophy associated with sun blindness is confined to the superficial layer of the center of the retina.

Light, radiant heat, and ultra-violet rays have been held accountable for other diseases of the eye, including gray cataract. This disease is said to occur more frequently and earlier in life in the country and in the tropics than in cities of the temperate zone, and it is notoriously common among glass blowers and other workers with fire, but exposure to radiation is only one of its causes.

Roentgen and radium rays may also produce very injurious effects, both inflammatory lesions in the front of the eye and disintegration of the nerve cells of the retina, though the chromatic structure is less affected by them than by ultra-violet rays. In working with Roentgen and radium rays the eyes should be protected by screens of sheet lead or lead glass, and the rays should never be sent directly into the eye.

The best protection against solar and other luminous rays is given by smoke-colored glasses. Blue glasses are less effective, as they transmit the short waves which exert the strongest chemical action. When the eyes are exposed directly to intense light, as in observing solar eclipses, tending arc lamps, etc., very dark glasses should be used. Glasses of lighter shade afford sufficient protection against reflected sunlight.

As a protection against ultra-violet rays the color of the glass is less important than its thickness, as all glass strongly absorbs these rays. But as no glass stops them completely, Schulek has devised hollow eye glasses containing a liquid which is entirely opaque to ultra-violet rays. Such complicated devices, however, are neither practical nor necessary.

Eyes already diseased and the eyes of sensitive, nervous, anæmic, and ill-nourished persons especially require protection. Such persons should avoid intense light, and wear dark glasses when they are necessarily exposed to it. Reading and working in direct sunlight should be absolutely forbidden. Good results often follow the use of colored screens, for some colors are more acceptable to one person, others to another.

Yet we must not forget that excessive sensitiveness to a degree of illumination that is borne by a normal eye without inconvenience is often only a symptom of a constitutional disease, which calls for diagnosis and treatment. It is certainly wrong to accustom the eye to darkness, for the eye requires light as the stomach requires food. Hence a weakened eye should be gradually accustomed to stronger illumination until it can endure full daylight, as weakened muscles are strengthened by judicious exercise.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

FREEZING OF WELLS.

THROUGHOUT many of the Northern States the freezing of wells and of pumps causes much trouble, and the greatest difficulty is experienced in keeping some wells open for use during the winter. Strangely enough, the shallow open wells give less trouble than the deeper drilled or double-tubed driven wells, in which the inner or pump tube is carried below the outer casing. The determination of the cause of the freezing and of means for its prevention is of so great practical importance that a study of the subject has been made by one of the geologists of the United States Geological Survey.

The freezing of wells is practically confined to districts where the air temperatures frequently go considerably below zero, and where the materials penetrated are either porous or contain actual openings and passages through which the air can circulate. A recent investigation of the wells of Maine, a large number of which are in granite, slate, and other compact, close-grained rock, discovered no instances of deep freezing. In Minnesota, North Dakota, and Nebraska, on the other hand, large numbers of wells penetrating porous deposits or cavernous limestones freeze every winter. In Wisconsin and Michigan freezing, though less common, occasionally occurs, and also in Iowa, Missouri, Kentucky, and Indiana.

Deep wells that freeze may also exhibit other peculiar phenomena, such as indraft and outdraft of air, producing sucking and blowing, changes in character of water, fluctuation of water level and, in flowing wells, changes in discharge.

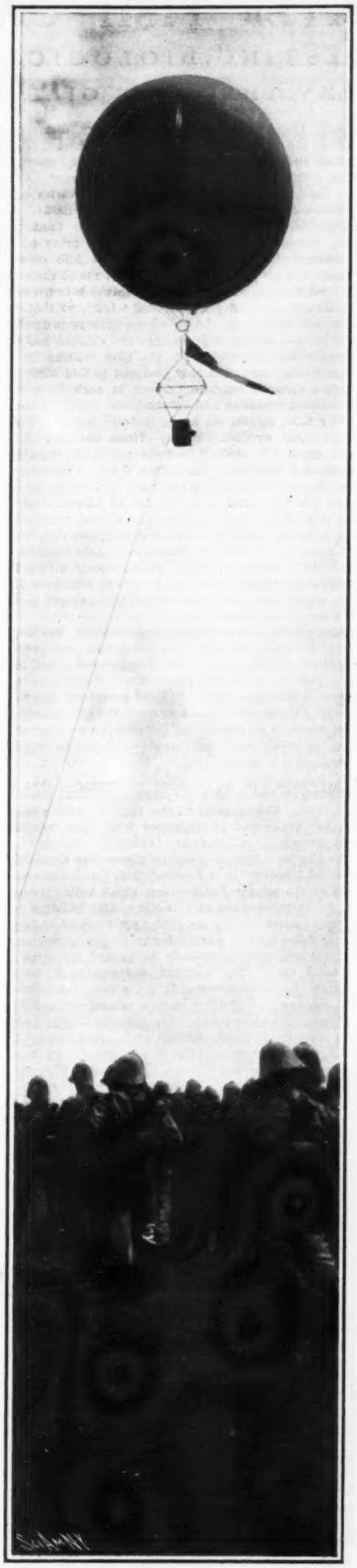
A study of the phenomena as a whole shows that they are connected closely with barometric changes. Freezing, indraft, low water level, small discharge and clear water are all characteristic of clear weather and high barometer; thawing of the well and melting of the snow about the mouth, strong discharge and discolored waters always accompany low barometer. The direct cause of the freezing seems to be an indraft of cold air at periods of high barometer. Change of weather, reversing the direction of the air current, produces the thaw.

Many of the simpler devices adopted to prevent freezing are common failures, while others are partly successful. The inherent difficulty lies in the construction of the well. The following suggestions are made by the geologist:

In open wells, where air obtains access through the soil and at the junction of the curb and cover, a cement cover should be tightly fitted to the curb, and the curb itself should be coated with cement for some distance below the surface.

In drilled or double-tubed driven wells the current of cold air drawn in at periods of high barometer between the outer and inner casing near the surface and passing out in a porous bed at the bottom above the water level will cause freezing if the water is pumped so that it stands in the inner tube above the lower end of the outer casing, and a long-continued current of such cold air may cause freezing of the ground water about and in the well tube. For this condition it is suggested that the space between the outer and inner tube near the surface be packed with some impervious material. A filling of cement resting on an improvised plug is probably the most effective. The home-made rag packing sometimes used is too porous to serve the purpose.

The same treatment is suggested for wells with leaky casings, for driven wells passing through rocks porous enough to permit the passage of large currents of chilled air during periods of high barometer and for wells in which the outer casing ends in some cavern or open passage—that is, the space between the well tube and the pump tube near the surface should be plugged tightly with impervious material. About some wells the ground crevices through which the air circulates are so numerous that immunity from freezing can be obtained only by plugging the space about the pump tube from top to bottom with cement.



THE BALLOONIST SEES THE ENEMY, WHO IS HIDDEN BEHIND RIDGES. HE SIGNALS TO THE FRENCH GENERAL.

THE BALLOON IN WARFARE.

Preparations are being made to equip all the tramway lines of St. Petersburg with electricity. The city lines now have a total length of 130 miles, so that the undertaking is a large one. Six years is the period allowed for completing the work. The first section of 28 miles is now under way. The Westinghouse Company is charged with the electric outfit, and the section will soon be completed. On the Obvodny canal a large electric plant, which will give the current for the first part of the lines, is building. Here the coal is easily brought by boat to the premises. The boiler outfit comprises six double boilers, and in the dynamo hall there will be three Westinghouse steam turbines of the Parsons type, which drive the dynamos. Working at 1,500 revolutions per minute, the alternators are designed for 2,200 kilowatts and 6,600 volts, with 25 cycles. There are two smaller turbine groups for the exciters, besides a turbine dynamo which charges a storage battery of 1,040 ampere-hours capacity, made up of 130 cells. By underground cable the high-tension current from the main station is sent to different points upon the tramway line, where substations are placed. Five of the latter will be used, receiving the 6,600-volt current by means of two cables, one of which serves as a standby. Transformers reduce the tension to 370 volts and this latter current is used to operate the rotary converters in the substations. The latter are of the 500 or 150-kilowatt size, according to the amount of supply which is needed, or each substation is designed to furnish 1,000 or 2,250 kilowatts. Direct current for the tramway line at 600 volts is given by the rotary converters taken to the trolley wire by sets of feeders. Upon the section of line which is in question here, the rolling stock includes no less than 190 motor cars, using the horse cars as trailers. On the motor cars the electric outfit consists of two Westinghouse motors of 40 horse-power.

HOW FRESH-WATER FISH CARE FOR EGGS.*

AN INTERESTING BIOLOGICAL STUDY.

BY THEODORE GILL.

THE belief long prevailed that fishes are indifferent to their eggs and young, and leave them entirely to the care of Mother Nature. One who was more excellent as a man of letters than as a naturalist, but who wrote, nevertheless, a very readable work on animated Nature, expressed the general belief once dominant. Oliver Goldsmith, in 1774, told his readers that "fishes seem, *all* except the whale kind, entirely divested of those parental solicitudes which so strongly mark the manners of the more perfect terrestrial animals." Many to the present time entertain that belief.

The species which manifest care for their young are so numerous that the present article must be restricted to those which are inhabitants of fresh water. Such are better known than the marine forms, as they are more easily observed and within the range of observations of a more numerous population. Considerable is known, however, of the habits of many of the dwellers in salt water. Parental care has been especially observed in the marine pipefishes, sea-horses, Pegasids, Solenostomids, Sparids (e.g., *Catharus*), Labrids (Wrasses), toad fishes, gobies, blennies, sculpins or Cottids, lumpfishes, Gobiesocids, etc. Doubtless analogous care will be found to be exercised by many more when fishes shall have been more thoroughly studied.

Naturally, the most common or frequent mode of care is the simplest, consisting of little more than selection of a site for the deposit of the female's eggs and subsequent guardianship of those eggs by the male. The concomitants of such selection are various. In the case of the American sunfishes, black basses, and crappies, the place selected is cleared of stones and weeds, and in the cleared places the eggs are laid. Some of the sunfish-like Cichlids and the North American catfishes, as well as the Grecian glanis, exercise similar means with slight modifications. Another kind of catfish, living in North Australia (Queensland), lays her eggs in the center of a selected area of a river bed, and, after having fertilized them, the fish accumulates stones from the surrounding area and piles them in a heap over the eggs. Other modifications of a general plan appear to be executed by other fishes, but the details remain to be investigated.

Oral gestation or carriage of eggs within the mouth of the parent fish is practised in a number of unrelated species. In Siluroid catfishes it is associated with enlarged size of the eggs, as in most Tachisurines and one of the Pimelodines (*Conorhynchos*), and is confined to the males. The Malapteruroid, or electric catfish, is also said to be an oral egg carrier. In other fishes the eggs of the egg carriers are not essentially different from those of normal habits, and many related species do not have the peculiarity. Such egg carriers are Cichlids of America (*Geophagus*) and of Africa (*Tilapia, Tropheus, Ectodus*, etc.), as well as species of the marine genus *Chilodipterus*, one of the Apogonids.

It is especially noteworthy that among the Cichlids are exceptions to the rule that the care taker is a male. In several cases it has been verified that the egg carrier is a female, and presumably, of course, the layer of the eggs. From evidence so far accumulated it would seem that the sex of the care taker is coincident with specific characters, and that when the care taker is a female the male is not.

One of the most singular devices for protection of the eggs is the formation of bubbles of air rendered tenacious by a viscous secretion of the mouth. This might seem to be so specialized a method that there would be no independent repetition by representatives of a very different group. In fact, however, the method, or an analogous one, has originated anew time and time again. It is manifest so far as known, in its simplest form in the fish-of-paradise (*Macropodus viridi-auratus*), which makes a floating nest of a mere conglomeration of bubbles, but other species of the same family (Osphromenids) evolve nidamental receptacles little more complicated, and among them is the celebrated Gourami. The nests earliest described, in which air bubbles formed an essential element, were those of Hassars (Callichthyids of the genus *Hoplosternum*), but in them the air or "froth" was used in combination with vegetable material ("fallen leaves or grass"). The large floating nest of the African *Gymnarchus*, recently described by Budgett, may, perhaps, be partly buoyed up by aeriform secretions. The future investigation of the structures involved in the secretion of such bubbles will undoubtedly yield most interesting results.

More specialized than any of the methods of parental care hereinbefore noticed is one manifested by certain American fishes. Those fishes are of a family named Aspredinids, peculiar to the fresh waters of South America and distantly—and very distantly—related to the catfishes of the North. In them it is the female that assumes charge of the eggs, and she does it in a strange and truly characteristic manner. After the eggs have been discharged from the ovaries (and presumably after they have been fertilized), the mother presses her belly and breast over them and they become attached thereto; then the areas of attachment of the skin become elevated into cupules round the eggs, like the cups of acorns round the nuts, and not only so, but strangulation ensues between each cupule and the general skin of the belly, so that the eggs and cupules are borne upon stalks or peduncles, and so they remain till the eggs are hatched and the embryos leave, after which the skin returns to its former condition. The only analogue to this occurs in certain anurous batrachians, but in such in a less specialized condition and on the back.

The most specialized of all the care takers are the sticklebacks, or Gasterosteids. These have an important organ (the kidney and its adjuncts) especially modified histologically to yield a thread analogous to that developed by spiders and used for binding the objects selected for a nest. So far as known none of the related fishes has the same structural peculiarity, but it is quite possible, if not probable, that their nearest relatives of the North Pacific—the Aulorhynchids—may have a similar history. It is scarcely within the range of possibility that an analogous structure like this should have been independently developed a second time in unrelated fishes.

One remarkable, and to some astonishing, fact is the want of correlation that may sometimes exist within a natural family between structural features and habits. This is strikingly manifest in the typical catfishes or Silurids. Neither of the parents of the well-known wels of central and western Europe appears to care for eggs or young, but the male of its near relation of Macedonia—the glanis—assumes a special charge of his consort's labor. Opposite ways of making their nests are practised by the North American catfishes on one hand and certain Australian ones on the other. Enlargement of the eggs is manifested in another group and is associated with their reception and carriage by the male in his mouth.

In the last English work on fishes, the Cambridge Natural History,* it is declared that, "with the exception of the pelagic *Antennarius*, which builds its nest in the sargasso weed in mid-ocean, nest building and parental solicitude for the young are confined to fresh-water fishes and to marine forms with demersal eggs. Pelagic ova must necessarily be beyond the scope of parental care." The so-called *Antennarius* is no exception; the species meant is not a true *Antennarius*, but belongs to a distinct though related genus—*Pterophryne*. Its history is a truly remarkable one and it has been more widely noticed as a nest-building fish than any other except the *Gasterosteids*. In truth, however, it does not build a nest at all. The whole story is the result of a misidentification of the eggs of a fish. In 1872, the celebrated naturalist, Prof. Louis Agassiz, attributed egg-bearing masses of gulf weed (sargassum), which he found in the gulf stream, to the *Pterophryne* which was abundantly associated with them. His equally able son, Dr. Alexander Agassiz, a decade later (1882), made known the remarkable egg raft which floated the eggs of a relative of the *Pterophryne*—the angler (*Lophius piscatorius*). This discovery may have led to thought, but did not discredit the earlier identification.† In 1905, however, Dr. E. W. Gudger and Dr. Hugh Smith both caught females of *Pterophryne* in the act of emission of egg rafts like that of the angler. Of course the parent of such eggs and egg rafts could not be the maker of the nests attributed to the *Pterophryne*. What fish, then, was the maker of the nests? The only eggs like those found in the nests are those of some flying fishes (Exocœtids). We are forced, therefore, to assume that a flying fish had laid her eggs on a frond of the sargassum, and that they had been fertilized by the male. These eggs have bipolar bunches of very long filamentary tendrils, and such have mechanically grasped and brought together the finely-divided branches of the sargassum, with the result that sub-globular masses have been formed in which the eggs are protected. They answer every purpose of a nest, but are they nests? If so considered, we must admit that the eggs and not the fish make a nest!

Some fishes have the males gaudily colored and larger than the females. The relations of the sexes to each other with regard to color and size are noteworthy, inasmuch as they have been generally misunderstood. One eminent ichthyologist (Dr. Günther), in an "Introduction to the study of fishes" (p. 656), dogmatically declared that "with regard to size, it appears that in *all* teleosteous fishes the female is larger than the male," and Darwin was assured by him that he did "not know a single instance in which the male is larger than the female."* Yet in the very chapter containing this assertion, Darwin represents three species of fishes selected by Günther in which males are figured of larger size than females; they are *Callionymus lyra*, *Xiphophorus helleri*, and *Plecostomus barbatus*. These species have the sexes trenchantly differentiated, the males in two cases being marked by a superior brilliancy of coloration and exuberance of fins, and in the other (*Plecostomus*) by a bristly armature of the head. The instances of increased size of the male are, in fact, numerous; in almost all cases when the males are decidedly differentiated from the females by brilliancy of color or other secondary characters the rule is that they are larger than the females. Like other rules, this may be subject to exceptions, but the rule is based on extensive observations.

During the consideration of the social economy of these fishes the question must often recur, How did the parental instinct manifested originate? It was easy enough in olden time to give an answer which would be regarded as all-sufficient in those days; it was a specific instinct implanted by an omnipotent Creator in every case. In these days of evolutionary belief, however, such an answer is equivalent to no answer. The instinct must be regarded as a development of an aptitude inherent in the fish itself.

Probably few naturalists or psychologists will be prepared to concede the possession of a sentiment of anti-selfish altruism by any of these lowly forms. The attribute of parental care must therefore be regarded as an outcome of selfishness, or, if you will, self-love,† a result of the sense of proprietorship. The eggs are the fish's own, and therefore they and the resulting larvæ are to be cared for as such. Perhaps it may be urged that the attention of the parental fishes is of the same nature as that of the hen to her young. We are not prepared to deny it. It may even be conceded, and yet the claim that the sentiment is the offspring of self-love can still be maintained. In fact, there is a regular gradation of self-love into the ennobled sentiment which impels the human mother to sacrifice her life cheerfully for *her* child and the degraded passion which emboldens the miser to suffer death rather than lose *his* gold. It is the basis of the courage of the farseeing martyr for his religion, for he is willing to sacrifice the present for an illimitable future.

Wonder may be entertained that one and the same method of care should have originated independently many times, but this will diminish on reflection. When the sense of proprietorship in the eggs has been established, protection by hiding them or clearing away of foreign substances that would interfere with them would not unnaturally follow. The mouth is used by many fishes for carrying, and the instinct to take up the eggs into the mouth for protection would be a natural consequence which might be, and repeatedly has been, developed into a habit. These and other provisions for the care of the eggs do not make excessive demands on our receptive capacity or imagination. It is only when we consider the case of the sticklebacks that the combination of aptitudes for nest-making impresses us. In them complexity is carried to an extreme. There is a sympathetic development of the kidneys and the testes; there is the synchronous response of both to external stimuli; there is the reaction of both on the brain and of the brain to external conditions; there is the elaboration of the wonderful thread which is used to bind the nest materials; there is the instinct to use the thread; there are, finally, the regular aptitudes and impulses which are shared with the majority of fishes. Such an accumulation and convergence of structural, physiological, and psychological characters almost force upon us a rejection, as explanation, of natural selection or sexual selection. The development manifested in the *Gasterosteids* is, indeed, one of the greatest wonders of the evolution of animal life. Nevertheless, it may not seem so extraordinary if we extend our researches beyond the class to which they belong.

Naturally, the elaboration for the perpetuation of the species in the *Gasterosteids* is unique in the class of fishes, but there is to some extent an analogous pro-

* Abstracted from the Smithsonian Institution's Report for 1905.

* Cambridge Natural History, vol. vii., p. 414 (1904).

† As Professor Agassiz did not notice any filaments on his eggs, I thought it possible that some real eggs of a *Pterophryne* may have drifted on the outside of an egg mass, but Dr. Agassiz kindly sent me a couple of eggs from the outside and they proved to have bipolar filaments and consequently to be eggs of flying fishes.

* Darwin, "The Descent of Man," N. Y., 1881, p. 335.

† See Whately's Morals and Christian Evidences, xvi., sec. 3 (Am. ed. 1857, p. 129); Ward's Dynamic Sociology, i., 679.

vision, although not so complicated, for the animal economy in certain other classes, as in the case of the webs of most spiders and the cocoons of some insects, as notably the silkworms. Mollusks and annelids furnish other illustrations. Of course, in those cases the analogous secretions are not produced by homologous organs, but by very different ones, very different from each other as well as from those of the sticklebacks.

As this article is intended to summarize existing knowledge respecting the breeding habits of some of the fishes in question, the original words in which the facts are recorded are given in most cases—in fact, wherever it could be done without interference with the mode of treatment or sequence adopted for the narration. The text, however, is by no means confined to information respecting the nests and breeding habits. Most of the species are little known or even quite unknown to many persons and yet are very interesting for other reasons than their parental instincts. Consequently quite detailed accounts of their habits in general, as well as their places in nature, are added.

THE MECHANISM OF THE MONSOON.*

THE WORK OF A MIGHTY WIND.

BY SIR GEORGE BIRDWOOD.

OUR terraqueous globe is wrapped in a layer of air about 40 miles high. This air is chiefly a mechanical mixture of nitrogen and oxygen gases, but it is also the recipient of all the volatile matters ever rising from the surface of the globe, and, among others, of the vapor of water in proportionally large quantity. The heat of the sun draws up the watery vapors from the seas and rivers, and so long as it remains in the state of vapor it is invisible; but on cooling it again takes palpable form, and falls to the earth from which it rose. It may be condensed and precipitated either by the greater cold of the higher spaces of the atmosphere into which it has ascended, or through being traversed by a colder current of air, or from its being whirled, with the revolving globe, away from the heat of the sun into the earth's cool shadow we call the night. The cold of a clear night precipitates it as dew, or as hoar frost, which is frozen dew. A fog is caused by the condensation of the watery vapor in the air that rests directly on cold ground. A cloud is a fog high in the air, and snow is a frozen cloud which, as it congeals, descends. Rain is caused by the gathering together of many clouds, or aerial fogs. The sun cannot dissipate them and their moisture gradually collects in drops, which fall as rain. Hail is a shower of rain, suddenly frozen as it falls. The heat of the sun also sets the atmosphere in motion, the winds which blow over the face of the earth being caused by the unequal heating of the air. When a fire is lighted, the air it heats ascends the chimney, carrying the smoke with it, and the vacuum caused in the air of the room draws to the hearth the colder outside air through every opening in the doors and windows; and when a city is on fire, so great is the vacuum caused by the upward draft of heated air, that the cooler surrounding air flows in to take its place as a violent wind; and so in accounts of great conflagrations we often read that the terror of the inhabitants was increased by the hurricane which blew at the same time. In such a fire it will be observed that the column of smoke from it does not go up for ever, but as it rises into the cooler air it spreads out on all sides like the branches of a palm, and gradually falls in "blacks" to the earth; and in this way bits of charred wood and paper are often brought back to a fire by the wind caused by it. Within the tropics the sun's rays fall vertically on the air, and its heated particles, constantly rising, form a column ever moving toward the poles. To fill the vacuum thus caused, colder air from the frozen poles rushes down over the surface of the globe toward the equator, and hence result the great polar and equatorial air currents, the direct courses of which between the poles and the equator are bent by the revolution of the earth on its axis, in the northern hemisphere into the northeast and in the southern hemisphere into the southeast "trade winds," or *vents alizés*, called "trade winds," not because they facilitate commerce, but because they hold a certain steady course, trend, or "tread" all around the earth. The air brought by the "trade winds" ascends to a great height in the tropics, and flows back toward the poles, in the northern hemisphere as the southeast "anti-trade," and in the southern as the northeast "anti-trade." The ascending air carries with it an immense volume of watery vapor, and as the air is quite calm on or near the equator, where the trade winds meet, this vapor, as soon as it reaches the upper atmosphere, is at once precipitated in the rains which fall within the tropics nearly all round the year. It is now proved that the Assyrians 3,000 years ago had anticipated Dr. Hunter's theory of the periodicity of sun spots, which implies that they also understood the theory of climate, as expressed in Ecclesiastes i. 6: "The wind goeth toward the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits." Had the world remained, as it probably once was, a waste of waters, the trade winds would have blown over it, and all round the year, uninterruptedly, and the moisture in the air would have fallen on the earth in three continuous belts, one corresponding with the equator, and the others with the calms of Cancer and Capricorn; these calms would indeed have reached to the poles. But the globe is divided between sea and land, and the land becomes hotter more quickly than the sea, as shown by the "sea breeze," that begins to blow about noonday in the tropics; and cools more quickly, as shown by the dangerous "land wind" which in tropical countries begins about midnight to blow over land toward the sea; and the consequence is that when the sun becomes vertical over any portion of the earth's land surface, it draws the surrounding air to a focus there; and in this way, in every latitude, the great primary winds and rains are broken into secondary, or local winds and rains, producing the differences in nature and season of the climates prevailing over the globe. Thus the manifold climates of the world are caused by the mutual relations of its atmosphere and sea and land; and all the changes of weather, shade and sunshine, heat and cold, calm and tempest, drought and rain, depend upon the movements the atmosphere is thrown into by the sun.

Owing to the excess of land in the northern hemisphere, the constant belt of rain where it exists between the trade winds, instead of corresponding with the equator, lies a little to its north, and the moisture gathered by the southeast trades only falls in rain when it reaches the tropic of Cancer, thus compensating the northern hemisphere for its want of evaporating (sea) surface. Similar modifications and compensations, on a smaller scale, occur in regard to each of the trades separately as the sun successively passes through the north and south ecliptic. But here we have only to consider "the rains," or "southwest monsoon" of Western India. India stretches out into the belt of the northeast trades, and were there undeviating winds the only rain this immense, outspread peninsula would receive would be that which falls from October to April during the northeast "monsoon." The rain which then falls is not brought by this wind, for as it blows from the high lands of Eastern Asia, it bears with it but little watery vapor, except what it may lap up in the Bay of Bengal. But the great volume of rain falling on India during the northeast monsoon, or winter rains, is really derived from the evaporation of the ocean about Australia, where during our winter months the sun is shining with all the force of mid-summer. The vapor there drawn up into the higher atmosphere returns in an upper current toward India, where it is precipitated through the lower current blowing from the northeast, and furnishes the northeast monsoon rains, on which the Indian winter crops depend. If India depended on the northeast monsoon rains alone, it would indeed be almost as unfortunately circumstanced as the peninsula of Arabia, wedged in between the high lands of Persia and Abyssinia. But observe what actually takes place. At the vernal equinox, March 21, the sun passes from the southern hemisphere to the northern; is first vertical over Bombay about May 15; reaches the highest point of his upward journey, or summer solstice, June 21; descending, is again vertical over Bombay about July 27; and finally, at the autumnal equinox, September 23, having traversed the whole tropic of Cancer, re-enters the tropic of Capricorn, reaches its lowest southern point, or winter solstice, December 23. Between May and July he shines down furiously on the sandy plains of Scinde and Rajputana, and the great grassy plains of Central Asia, from which so vast a column of heated air ascends up through the atmosphere that the draft caused has the power not only to reverse completely the normal direction of the northeast trade, but even to deflect and draw the southeast trade toward India. Thus is the southwest monsoon brought about. This mighty wind, laden with the moisture gathered from the Indian Ocean, strikes the Malabar Coast and the Concans at nearly right angles, and there, chilled by the cool, green, forest barrier of the Ghats, pours down its condensed vapors on Western India for four months in violent rains, which are ushered in and depart with the most awful thunderstorms; and thus also it is that the temperature of India is lowered during months that otherwise would be so hot as to make the country unendurable. The Deccan slopes eastward, having been upheaved chiefly by the eruption of the Western Ghats, and the superfluous rain which falls on them, that does not flow off in the mountain torrents of the Concans, slowly drains off to the Bay of Bengal in such continental rivers as the Godavery, Cauvery, Pennair, and Kistna. But the Ghats do not line the whole coast; they cease about Surat; and there the Sautpura and Vindya mountains condense the clouds borne by the southwest monsoons, and pour their waters into the Arabian Sea by the flooded Tapti and Nerbudda, the only Deccan rivers flowing westward; while from the Aravalli hills in Rajputana the Sabarmatti flows southwestward through the fertile plains of Gujerat. The southwest monsoon reaches to the wide plain of Hindostan, the Punjab, and Scinde; and all round the coasts of India and Southern Asia, within the influence of the great solstitial updraft from the deserts of Rajputana and Central Asia, we find the phenomenon of summer rains. At the very time, also, that the sun is drawing the vapors of the Indian Ocean toward the Western Ghats, his rays are melting the snows of the Himalaya and Hindu Kush, which flow down to the Arabian Sea and Bay of Bengal, in the perennial streams of the ancient Indus and sacred Ganges.

The mystic Saraswati, which once flowed through Rajputana to the sea, has long ages ago disappeared through the desiccating action of the summer solstice, or "standing still" of the sun over that country between May and July. The evaporating away of this river of Hindu poetry is a proof of how little unphilosophical political agitators take into account the play of natural climatic forces in India. We have traced the course of the sun through Cancer and Capricorn, and it will have been observed that he shines vertically twice as long over his "turning points" as over any other part of his ecliptic course. He appears to stand still over these points, which are hence named the summer and winter solstices; and so it happens that all the lands lying about the 23d degree north and south of the equator under these sun stations are desert lands. This is clearly seen in the northern hemisphere, where there is so much land, in the deserts of Rajputana, Scinde, Baluchistan, Persia, Arabia, in the Great Sahara of Africa, and the Tierra Caliente of Mexico. In the southern hemisphere there is very little land along the solstitial line, and what exists is surrounded by the widest oceans; but Central Australia is a desert, and the Kalahari desert stretches across South Africa, and the Pampas through South America. India is, in fact, one of the blast furnaces wherein the winds of the world are evolved, bearing with them everywhere fire and hail, snow and vapors, and the life-giving, purifying oxygen disengaged in ceaseless and immeasurable volumes from the perennially green primeval forests of the tropics. So placed at the very focus of her mightiest operations, man must stoop very humbly to Nature if he would hope to understand her and subdue her to his purposes, and this, through 3,000 years' experience, the patient, religious-minded Hindoo has learned to do; and it is certainly not for the farmers of our mild, equable climate to be too sure of being able to improve on Hindoo husbandry, or to insist too energetically on the superiority of their own doctrines and methods. The real wonder is that India does not suffer more from agricultural distress and famines, and the reason of its comparative exemption from them lies in the phenomena of the southwest monsoon. But most precarious, from a merely scientific point of view, is the yearly prospect of the seasons in India between the date of the solstitial hyperthermescence of the Rajputana desert and that of the storm of rain it calls up from the vasty deep. It always comes, but one might every year repeat the question, "Will it come?"—with the prayer, "God help its coming!" Any alteration in the condition of Rajputana by improved irrigation, or extended forest planting, or by an increase of its desert area, might produce incalculable results of the most disastrous character. The destiny of India seems, in fact, to hang in the balance between this desert country and the deep sea.

* Abstracted from the Times (London).

Both the Italian and French governments are encouraging the use of antimony pigments, which have the advantage over white lead of being innocuous, and over zinc paint of being permanent and sun proof. Antimony is also obtaining a wide application in the manufacture of bearing metal and other alloys.

THE BORORÓ INDIANS OF MATTO GROSSO.

A STRANGE ABORIGINAL TRIBE OF BRAZIL.

BY W. A. COOK.

IN November, 1900, while in Goyaz, Brazil, the writer received a communication from the Smithsonian Institution, requesting photographs and descriptions of the aboriginal tribes of Matto Grosso, and a collection of objects made and used by them. I here give some account of the journey to Matto Grosso and of the manners and customs of the Bororó tribe.

Senhor Antonio Candido de Carvalho, a Brazilian explorer of large experience and influence, and thoroughly acquainted with the region to be traversed, had arrived at Goyaz with his light traveling caravan, and the evening before I received the communication, had invited me to accompany him on a visit to the villages of the Bororó Indians scattered over that extensive region of Matto Grosso between the capital of Goyaz and Cuyabá, the capital of the State of Matto Grosso. I did not hesitate to accept the invitation, for with Senhor Antonio, whose influence over many of the Bororó tribe was great, as a companion and guide I would be at much advantage in doing the work desired.

As Senhor Antonio Candido had his equipment, I needed only to buy a mule to carry my baggage, and a horse to ride upon, a tent, raincoat, riding boots, and some bright colored cloth, knives, beads, fishhooks, mirrors, handkerchiefs, etc., to trade with the Indians.

We left the city of Goyaz, nearly 700 miles from the Atlantic coast, on November 17, and, following the divide between the great river systems to the north and south, we rode nearly 600 miles before we began to meet with the Bororó Indians. The last sixty or seventy miles was through an exceedingly wild and almost unknown region of forest and dense bush that made traveling almost like pushing through a network of barbed-wire sieves, where we were constantly raked and torn, and were drenched by the daily thunderstorms.

On January 9, 1901, we reached the Rio Ponte de Pedra, about forty-five miles north of its junction with the Rio São Lourenço, where the latter bends nearly westward. Senhor Antonio had recently thrown up here a simple palm-branch, stake-walled ranch, near an important village of the Bororó tribe on friendly terms. The place is called Ta-Dare-Mano Paro, "potato bank," or "place where tubers grow."

As soon as our arrival became known our ranch, scarcely more than an open shed, began to fill rapidly with our painted friends of all ages and sizes, and of both sexes, who came to observe us and to see the marvelous things we had brought from our enchanted world. They poured in upon us regularly at the break of day and stayed faithfully till the shadows of night began to deepen; and though coming and going constantly, we always had our full complement. If we opened one of our pack-mule trunks, our visitors were on the alert to handle whatever might strike their fancy. If we ate, every mouthful of food was closely

BORORÓ HOUSE, BRAZIL.

scrutinized, and whatever we did was observed with the closest attention. They reclined on our boxes, sprawled on our tables, leaned against the posts, squatted on the ground, and hunched down around our pot as it boiled, always leaving a patch of paint wherever they sat or leaned. Some smoked, others lazily picked and ate the kernels from a roasted ear of corn, others nibbled the white cheese-like heart of a diminutive palm that furnishes a considerable part of their food; the boys devoured bits of fish roasted black, or shot at a stick or a stump with their crude bows and arrows. Just outside the door men gossiped, vacantly gazing, but never once toward the one they addressed, or they asked us a few questions in the limited language that we knew in common. The women and children usually formed an outer fringe to this group. Whenever there was prospect of obtaining beef our congregation at once largely increased. They never stole anything that was distinctively ours, though they would take anything bought from them if they had an opportunity.

INTERIOR OF BORORÓ HOUSE, BRAZIL.

The long, straight, coarse black hair of both males and females hangs in a tangled mass about their shoulders, except above the forehead, where it is kept chopped off to form bangs. Nearly all the young unmarried people plaster these bangs with a sort of red putty made from the small yellowish-red fruit of the burity palm and fish oil, and the same paste is used to paint the entire body. Boys and girls who are esteemed by their parents also have the foretop arranged in this way, and a few of the latter who are regarded with special favor have it plaited with a layer of beautiful red feathers. Again, young men, as well as boys and girls, who are liked by their parents have their shoulders gummed and plaited with white feathers, somewhat resembling a shirt-vest. Other young men wear feather armlets. One woman was covered with white feathers from head to foot, with a brilliant plume in her hair. All young men and boys wear suspended from a hole in the lip, bored during infancy, a kind of chain called nogodau, about six inches long, made of flat oval-shaped bits of shell, terminating in a red feather. The older men have a plug in this hole, for if left open it causes difficulty in drinking. The young males wear around their loins a girdle over an inch wide woven from long tongue-like palm leaves. A large crescent is worn on the breast, suspended from the neck. A charm, worn on the breast and greatly prized, and with which they are very loath to part, is made of rows of monkey teeth bound to bamboo rods sometimes eight or more inches long. The huge horn claws of the tatou canastro (*Priodontes gigas*) are also worn on the breast, and are much esteemed. Coils of square plaited cord hang around the neck, and ten or fifteen yards of hair cord, made of the hair torn out of or cut from the heads of mourners during funeral ceremonies, are worn by men wound around the head. Beyond the ornaments above described the males dress or bedeck themselves only on special occasions.

Females above six to nine years of age also wear a sort of corset, made of the inner bark of a tree, especially tanned and prepared, and which encircles the body twice or nearly so. It is much like a bottomless cheese box or bushel measure, and evidently at first causes much discomfort. Another strip of bark about six inches wide and four feet long, so prepared that it is almost like cloth, passes between the legs from front to back. With this gear, a female is considered properly dressed. When she becomes old, she often discards the corset and uses the soft bark instead.

When a handkerchief or a small piece of cloth was obtained from us, the men tied it around the head or waist, with the points in front and the fly falling behind. The female and boys would hang it shawl-like over the shoulders or around the waist.

There were thirty huts in the village that encircled in a very irregular way, facing in every direction, a very large hut that stood in the center and was called baehytu. Bae (by) is the name of the ordinary family hut. This baehytu is the bachelors' hall, the headquarters of all the unmarried men, the workshop where the men make weapons and ornaments and instruments, the dining room, the town hall where most public functions occur, and the club where visitors are received and entertained. The baehytu of the Ta-Dare-Mano Paro village is about fifty by thirty feet, and eighteen or twenty feet in height. The ridge-pole rests on three tall posts, and shorter posts support the principals. To the rafters and to the wall posts are tied a few bamboo poles, and upon these are bound, rather sparingly, long palm branches with tongue-like leaves to keep out most of the rain, the wind, and sun. It is entered through an opening at each end, like a hole in a haystack, and within is always damp, gloomy, and foul smelling. The family huts, built of the same material, are mostly like a roof resting on the ground and strongly resemble an old haystack with a hole eaten in each end, though occasionally the hut is raised a little and woven palm-branch tongues form a basket-like wall. These huts are made dark that they may be free from flies, and are dens of rubbish and filth. Stuck into the roof are bows and bundles of arrows, war clubs, fishing gear, and instruments and ornaments not in use at the moment. The occupants of this human lair sprawl on a palm-leaf rug, with a log of wood four inches in diameter for a pillow, sleeping, or gnawing an ear of corn, a bit of fish or vegetable, or sitting tailor fashion, make beads, arrows, or other objects, or kneeling by the little fire prepare food. When the filth becomes unbearable or disease is prevalent, they do not trouble to clean house, but simply abandon and burn the old and build a new one on a clean spot. Usually the entire village moves to a new place some distance away.

Two families nearly always occupy one hut, and sometimes three or four, or even five. Each family has its camp-fire, which is very small, since the gathering of firewood costs the women much labor. Just over the fire and about two feet above the ground is a small wooden rack where fish and meat and vegetables are roasted or baked. About five feet above the fire is a second and quite large rack, the family pantry, where perishable food is preserved by the smoke of the fire below. Each family or individual has its mattress or rug of long woven palm leaves, and each one a pillow made by binding a small roll of green banana stalks or a length of wood three or four inches thick.

A day or so after our arrival a child of seven or eight years belonging to one of the leading families died. This gave us an opportunity to witness a strange ceremony.

A loud, deep, prolonged "hee-aw, ho-o, ah-ah," was bellowed by a quartette of naked, painted, and feathered savages, squatting slightly in unison with each note, and shaking huge calabash rattles. This was accompanied by the wailing chant of a chorus of women standing behind the quartette and waving fans to keep away the flies. The snort of two huge flutes, the barking of the calabash trumpets, the lament of the savage mother, her body besmeared with her own blood, kneeling by the corpse of her child, the hairs jerked from her head, half a dozen at a time, by a female crouched behind her, the lamentations of the father, with his hair clipped, as he kneeled on the other side of the body and recited the virtues of the deceased loved one, and the low mournful chant of female relatives or friends as they slashed their legs and arms, or even their entire bodies, with sharpened shells—this was the drama that unfolded itself one beautiful summer morning as we crept into the baehytu of the Ta-Dare-Mano Paro village. The little daughter of a chief had been summoned from her earthly bae to wander with the bope (evil spirits), and the funeral ceremonies were in progress.

When a Bororó dies, his body is wrapped in the palm-leaf rug which has served as his bed and is carried to the baehytu, where the spectacle described above makes time hideous until the first sunset after death; then as the sun goes down the chorus becomes hushed, and the bundle of remains, with a nine-foot pole passing through the roll, is carried to the public play-ground just outside the baehytu, and about ten inches of earth heaped over it. Here it rests a week that the flesh may separate from the bones, and each evening at sunset the sorrowing family and friends gather around the little mound, their faces toward the fading light, and murmur a low chant, pleading the virtues of the departed one. Every evening, also, water is thrown on the little mound to hasten decay. The day before the remains are to be resurrected is again a gala time. A bamboo whistle brilliantly decorated with feathers is blown at intervals to summon the bope, while within the baehytu the man who invites the bope to resurrect the body is decorated and fêted. He wears a skirt of palm leaves hanging loosely from a belt, over his shoulders a cloak of the same material descending below the waist, and over his head is a veil of slender palm leaves to prevent his recognition, and his name must not be spoken. On his head, to represent the setting sun, is a pariko, an ornament of brilliant feathers of the makaw and parrot. Thus arrayed, he dances up and down sideways like a crab, while a companion and a rear guard execute similar movements. After a time, accompanied by all the males, they leave the baehytu for the play-ground just beyond the village, all dancing as they go. Here the soul-representative and his body guard, exhausted, sit on the ground to rest, and a substitute proceeds to call the bope by offering some tobacco or other delicacy. Soon one offers himself as a bope-representative by dropping on all fours and creeping slowly toward the caller, emitting a noise like the grunt of the tapir; and finally, springing to his feet, he rushes with outspread arms to the center and quietly stands on a spot prepared for him. Others repeat the performance, until five are in line in the center. They are smeared from head to foot, hair and all, with a coat of clay. Black streaks are painted around the eyes and other decorations added, and the five bope again drop on all fours, and the caller (still acting as adjutant for the decorated soul-representative, standing in the path to the village) beckons and calls as before. At the same time the remaining band seeks to drive the five bope to the village by pushing them with instruments used to frighten evil spirits, jumping, screaming, and swinging their arms. But the bope advance slowly, constantly making their squeaky grunt. Just as they enter the village path a man suddenly springs up before them, frightens them with a yell, and they wheel and begin creeping away from the village. The drivers then become more frantic than ever to prevent the escape of the bope without resurrecting the body. Finally the bope again head toward the village, enter the path, suddenly spring to their feet, mount their "horses," fellow red men, gallop into the village, dismount, squat around the burial mound, and claw the earth with their fingers. But this is only a feint of what is to happen later, and the body still lies covered, while the bope retire, having finished their part in the drama for the present. A large fire has now been kindled, and in order that the spirit of the departed may not return to haunt the family his belongings are passed piece by piece to the adjutant, who hands them to his

BORORÓ WOMAN ADORNED WITH FEATHERS.

master, who throws them in the fire while they both dance and waltz around it. This done, the soul-representative and his adjutant sit astride the grave, and having called the father of the deceased, who crouches beside them, he fortifies him against evil spirits by passing a hand over his head and face, whispering and blowing in his mouth and ears, after which he deposits all his paraphernalia, except the pariko, upon the grave. The day's performance concluded, all the males sit in two groups just outside the baehytu, and the daily feast is served by the females.

Early next morning the bope representatives resurrect the remains by means of the pole, carry them to the river, scrape and wash the bones and pack them in a basket, keeping the skull separate when they wish to decorate it. They say that the resurrectionists are not summoned by men, but directly by the bope, and no one is supposed to know who they are.

When the village awakes to find the bones already prepared, the din is again unchained, the mother and female friends again slash themselves from head to foot, wail, and daub their bodies with black paste made principally from a fruit called genipa-pa, while two men sit on a palm-leaf rug and decorate the skull with a layer of bright red makaw feathers. This weird drama continues all day with little interruption, the players and singers relieving one another from time to time. And if some of their brethren from a neighboring village should visit them, the bakororo, as this noise is called, may continue all night and all the next day. Finally the concert ceases, and at sunset the basket of bones is laid away in the little cemetery outside the village, where the bope will take possession of them in due season, though only the priest is supposed to know when. Through constant howling during the bakororo, the family of the deceased become so hoarse that they cannot speak above a whisper, but the drinking of clay water, they say, relieves them.

As the Bororó is "very bad," they say, he is doomed forever to wander and suffer in the lower regions and be subject to constant eviction. He takes up his abode in the bodies of certain fishes and mammals, and when the creature dies the spirit must seek a new dwelling and be exorcised from the bodies of fish, fowl, or beast by the priest before the meat can be eaten. To eat it without this ceremony would cause sickness and death. Not every creature, nor even every member of certain species, is inhabited by a bope. Its presence is indicated only by certain markings or other peculiarities. In exorcising the bope the priest faces and calls upon the sun with loud yells, ecstatic jumping and trembling, slapping the fish, spitting and blowing into its mouth. Corn also must be exorcised, as they say they were once made desperately sick by eating it without this ceremony. The priests are exalted to an abode with the sun at death; they are not chosen by men, but by the bope. It comes about somewhat in this manner: Some day a Bororó may be taken with a fit, and a priest of the tribe will be called to determine the disease and to say whether he will live or die. After consideration he may say to those present, "Piadudu [humming-bird] is in deadly combat with a bope. If he surrenders to the bope he will become a priest, but if he continues to resist he will die." If Piadudu recovers, it is considered that he has given himself up to the bope, and is therefore qualified for the priesthood. But the certificate of priesthood seems to lie largely in the ability to throw themselves at will into a savage ecstasy.

When a Bororó is ill, a priest is called to determine whether he will recover or die. On entering the hut and looking at his sick tribesman and concluding that he will probably die or should die, he will count his fingers, and each time he touches one finger will repeat, "Meri, meri, meri, meri, meri, bi," meaning that the sick man will see five suns, five days, and die, or he may say, "Nadua, nadua, nadua," etc., "bi," meaning sleep, sleep, etc., five days, and die. If at the end of this time he still lives, the executioner, sent of course by the priest, will suddenly appear in the hut, sit astride the sick man's stomach, and strangle him to death, for the reputation of the priest must be maintained. The priests are probably responsible for not a few deaths. They are the bane of life in the tribe. They must nurture the delusion that they can communicate with and have influence in the other world and power to avert or cause evils and calamities. They are therefore on the alert to take advantage of any propitious occasion to prey upon the superstitious fears of their fellow-tribesmen. They are freely supplied with food by their tribesmen in order to retain their good will.

The Bororó seem to have no idea of God as the Christian understands Him. They consider the sun as the fountain head of majesty and power and even of beneficence, and as the abode of the great priests who have passed to the spirit world and fear him. Bope means spirit or disembodied soul, but they seem to have no idea of a good spirit. The bope, who are evil spirits, must therefore not be offended though they must be driven away. To drive the spirits off, they use a bull-roarer, a peculiar instrument made of a slab of wood about half an inch thick, shaped something like a fish, and of varying size, hung by a long cord from the end of a stick like a fishing rod, and swung round and round through the air. As it swings and rapidly revolves, it sends forth loud sounds to a surprising distance, pitched from a sepulchral moan to an unearthly shriek, the wail rising and descending the scale according to the rapidity of the swing

BORORÓ METHOD OF CARRYING WITH HEAD STRAP

or the size of the instrument. To hear several of these roarers at once certainly produces most unusual sensations, particularly when operated, as we heard them, during a tropical storm amid the play of the lightning, the crash and roar of thunder, the falling floods, and dismal gloom. No female is allowed to see this instrument under pain of death. New ones are made as occasion demands, and they are burned immediately after their need has passed. We entered the baehytu as some of these roarers were being made for the funeral prelude. There was deep silence, and the word bope was whispered low and mysteriously. Certain warning calls are given some hours in advance of the time for bringing the roarers into use, and, hearing these warnings, the females enter their huts, close the openings, and hide their heads. The roarers are manipulated outside the village up and down through the bush. We had difficulty in securing examples of these instruments. They were brought to us at night securely wrapped and amid the greatest secrecy, every precaution being taken to make sure that we would keep them where there would be no possibility of a female seeing them. We also had much difficulty in obtaining the base flute which is played only over the bones of their dead. A native said to me, "That is a very bad instrument; you must not take it. If you do you will never return."

The Bororó are expert swimmers and are fishermen of the highest order. One mode of fishing is to swim out into the river, three or four miles above the village, with a net called buke, like a great bag, its mouth secured to two parallel rods nine to twelve feet long, bound together at their ends. When one or more fish are seen, the mouth of the sack is opened by springing the rods apart, and with wonderful dexterity the fish are bagged and the mouth of the net quickly closed by allowing the rods to spring together. The fisherman then plays the game, especially if it be large; gradually rolls the net over the rods till the fish cannot move, brings it to the surface and kills it with a club, which he trails by a cord from his neck. The fish is now taken from the net, strung on a cord, and floated along with the club. Sometimes two or more fish of twelve or fifteen pounds will be taken at one catch, or may be one weighing as much as the man himself will be bagged in this way. A Bororó will remain in the water an hour or two continuously, and return ashore with six or eight large fish. They have learned to turn their bodily strength to the greatest account while in the water.

Another method of fishing is with a bone harpoon, to which is secured a long cord and a short detachable bamboo staff. With this the fisherman enters the water, and finding a large fish in the shadow of a rock, following it with great expertness if it moves, he plunges the harpoon into it even at a depth of fifteen or twenty feet, while the staff detaches itself and remains in his hand with the end of the cord secured to it. The fisherman now returns to shore and plays the fish until he lands it.

Another method, when fish are scarce, is for one gang of men to enter the water with their sack nets, three or four miles above the village, form a chain across the stream and make a great commotion and drive the fish downstream to a point near the village where another gang with sack nets awaits to bag the game. Sometimes they fish at dead of night, but as a rule they rarely leave the village after dark except in war.

Late one cloudy afternoon we had the pleasure of seeing the Bororó play Mano, the name of the small banana-like plant used in this game. It seems to be a close imitation of some of the performances of ants. Indeed, the imitating of nature occupies a large part of the Bororó life. Early in the day they went up the river and cut many of these plants, which grow three or four feet high, floated them down on rude bamboo rafts, carried them to a point about 600 yards from the village, and placed them in two piles, one for each of the two parties into which every village is divided—the Xeráede and the Ta Nagarêde. Each group prepared its material by cutting off the tops of the mano, leaving a spongy stem about eighteen inches long, and when all was ready each made its pile into a huge wheel. This was done by two men for each wheel standing face to face, about five and a half feet apart, with two long, strong, parallel cords between them, reaching from the ground up over their shoulders, for binding the material into a wheel. The mano was then piled in between each pair of Indians acting as posts, and when the weight pressed too heavily upon them, they were supported by other Indians leaning against them, back to back. When the mano was all in place the cords were drawn over the top and tightened. The wheels were next laid flat on the ground and a string of men pulled with all their strength on each of the four ends of the cord for each wheel, while others pounded the spongy mass so close that it could not burst. Each wheel was again set upright to be seized and hurried off in the mad race for the village. But the Bororó must do things decently and in order, so a Ta Nagarêda man with much ceremony steps quickly over to the Xeráede, takes a man by the wrist, trots him around his wheel and stops in front of it, meaning by this that his wheel is delivered to its party, and the same ceremony is repeated by the other side. Each man who has now been presented to his wheel and his wheel to him, politely introduces others of his own party just as he himself was introduced, until all surround their own wheels. At a given signal each group seizes its wheel, throws it up on its shoulders, and runs pell mell in a race to the village. Each squad of these human ants tries to keep its wheel upright as it sags this way and that, or finally rolls over on the carriers, to be quickly straightened up, and rushed along again, each crowd endeavoring to keep the lead. As they entered the village one wheel burst through the side of a hut. Finally both parties threw down their wheels in the public square at nearly the same moment, greeted by the applause of the whole village. They now all retired to partake of their evening feast and left the wheels to be torn apart by the women and children for use as pillows. A feast always ends the game, each party eating separately.

When about to go on a fishing trip, especially when fish are scarce, or on a hunting expedition, they sing the bakaroro, which seems to be a hymn in praise of the beast or fish that is to be hunted the next day. It is sung within the baehytu after nightfall and several times a week when food is scarce. The good qualities of the animal are named, and how well it will be treated, and the use that will be made of it when taken. In this anthem, the man again exhibits his imitative qualities by attempting to reproduce the animal sounds which he has been most accustomed to hear. Frogs and toads are especially favored. While visiting the Kogy ao Paro village, about twenty miles away, we spent a night in the baehytu, and listened to the bakaroro at close quarters. The din, the darkness broken only by the red light of the fire that cooked our beef, the stagnant air, the noise of this squad of human beings reproducing the sound of everything that dwells thereabout, made one imagine that he had passed from the earthly to the unearthly. After the bakaroro, the singers went outside the baehytu, and having cleared away the black earth, brought ashes and made animals in relief on the ground, especially the tapir, which they were to hunt next day. This is also a tribute of honor to the animals. They also sing the bakaroro in honor of a visitor. As they had seen men hunting on horses and admired this method, they formed a horse in relief with a man mounted on it.

It is always the man (mêdo, from meri, the sun) who does the light work, while the woman (arêda, from arê, the moon) is the beast of burden. She it is who must provide food for the family. Her lord may go fishing or hunting, and if he brings home something, well and good, but if not, he expects to find food on returning to his hut.

There appears to be no regular marriage ceremony among them. The girl is betrothed before reaching the age of eight or ten, and married at from ten to fourteen or even younger. She becomes betrothed by her would-be husband presenting to her parents a specially fine fish, or some animal whose flesh is much esteemed, he of course having made known in some way what he wishes in return for such a present. When he would take his betrothed to himself, he makes a second similar present to her parents and they deliver her to him in his hut. The Xeráede and the Ta Naragêda in each village eats, fishes, hunts, works, and plays by itself. A man of the Xeráede cannot marry a woman of his own party, but must select one from the Ta Naragêda, and *vice versa*. The Bororó have a tradition that the Xeráede once possessed all things that the Bráede, civilized men, now possess, such as knives, axes, blankets, etc., but as these things brought calamity, they were obliged to abandon them. There is evidence that these Indians are made up of what were once two distinct tribes. The Xeráede tradition might indicate that the Bororó may have come in touch with the civilization of the Andean slope in ancient times.

The Bororó, like most other savage men, look to nature to furnish them with nearly all their food. About the only thing they cultivate is a little yellow corn, and even this with great difficulty, for they have no steel instruments. They are communistic, and therefore little inclined to attempt anything extensive in the way of agriculture or to provide a stock of food, for if one family should do this, it would only be to divide the harvest with the rest of the community and leave themselves with nothing for the morrow. There is thus no incentive for labor except when hunger drives them in search of food. The Bororó is therefore acquainted with about everything edible in his environment, and he knows when and where and how to obtain it. The river is by far his most important source of supply, and when fish are abundant in December, January, and February, he grows fat. The rest of the year he is obliged to look largely to the woods for food, though he is a more expert fisherman than hunter, and individual families wander abroad through bush and forest along the rivers. As to fruit and vegetables, the palm is his never-failing friend. It will always provide him with something when naught else can be found. At every season of the year he may obtain the white cheese-like heart of a diminutive palm. The fibrous trunk of two or three other varieties, pounded and wrung out, gives a starchy, liquid-like milk which, when boiled in a clay pot and mixed with the yellow fruit of the burity, makes good soup; or he may dry the starch and make it into bread. Another palm yields a yellow fruit bigger than a very large plum, which he eats with a relish, though we considered it very insipid. Still another species furnishes an unfailing supply of nuts about the size of a goose egg. This he throws into the fire for a few minutes, then removes the thin outer shell, and scrapes off and eats a thin insipid substance very much like the inner bark of the slippery elm. He then splits open the remainder of the thick shell and obtains a white woody kernel, which he eats raw or pounds in a wooden mortar and makes into a loaf to be wrapped in a large leaf and baked into bread in the ashes. This is considered quite a delicacy. The palm also furnishes material for his bows and for the shafts of his arrows. The long tongue-like leaf furnishes a silk or band of strands called bokigo, which he rolls into a single strand as he sits cross-legged on the ground, and by twisting this strand with others he obtains cording with which to make his fishing nets, harpoon lines, etc. From the ground he digs two or three varieties of the potato family, which he boils. Corn is eaten as roasting ears or cut from the ears and boiled. They use no salt. The large ant bear is considered the most valuable of all creatures. Nearly every part of its body is utilized. When discovered, it is driven to the village for slaughter in order to secure its blood. After this comes the tapir, which is also greatly esteemed. When food is plenty they eat nearly all the time when awake, and even rise several times in the night to take a little food. While we were in the baehytu at the Kogy ao Paro village we saw thirty-three men devour upward of 25 gallons of boiled shelled corn within an hour and a half, and they had been nibbling roast ears all the morning. The two men who had accompanied us from the Ta-Dare-Mano Paro were induced to eat from every pot as they were brought in one at a time. They seem never to get full and will eat as long as there is anything to be had. While at work making bows and arrows and ornaments, they are nibbling food, if they can obtain it. They eat the corn mush squatting and standing around the pot, using large oyster-like shells or broad leaves as spoons.

Their language seems quite free from clicks and from deep gutturals. The names given to animals are often in imitation of the sound produced by the animal. Ki, for instance, means tapir, and is a close imitation of the note of this animal; pobu means river or water; pobu camahina is great river; meri rutu, sunset; adugo, spotted tiger or ounce; and aigo, brown ounce. Báekimo is the negative; Boe by báekimo means "Indian die not"—"I will not die."

They are wonderful whistlers and seem able thus to communicate whatever they otherwise would by speech.

All the fine and ornamental work is done by the men. A great deal of time and labor is spent in making seemingly unimportant articles, and the time consumed in shaping and burnishing an arrow is astonishing, generally the larger part of two days. The ornament worn around the neck is made by the reciprocating motion of the point of a sharp instrument of flint or of iron or steel, if they can obtain it, fastened near the center of a roughly shaped shell. A fire is kindled in the same way by boring a wooden rod into another bit of wood. When holes have been made in bits of roughly shaped shells they are strung tightly together on a cord or rod, and a bit of grinding stone is rubbed up and down their edges till they are of equal size. A wide belt is made by placing two bamboo rods in the ground two feet or more apart and winding around them the thread that is to serve as warp, placing each thread close beside the preceding one. The woof is then worked with the fingers and a wooden blade.

Wild cotton is pulled out and rolled into thread by hand just as the fiber of the palm is made into cord.

Bows and arrows are used in war, but they prefer to fight at close quarters with a club of heavy wood, shaped nearly like a baseball bat, about 3½ feet long. A smaller club is also used as club or sword.

The ceremony of naming baby boys is very interesting. Early in the morning the family and friends, with the little one coated and ornamented with feathers of crimson and white, accompanied by a priest, take up a position on the highest ground near the village. At sunrise, the priest pierces the lower lip of the embryo warrior with a long, sharp, bone-pointed instrument made for the occasion and decorated with many-colored feathers. At the same time he pronounces "Piadudu" or the name of some bird, animal, or object whose name the child is to bear. "Piadudu," softly repeat the family and friends, and thus "Piadudu," humming-bird, a favorite name, becomes the name of the child. They are very jealous of their

names and will not make them known to any one not belonging to their tribe, always when asked responding "parduko"—I do not know. A woman is totally disfranchised and can scarcely consider herself a citizen. She is merely an adjunct to the man.

These savages, although so filthy in their habits, are sometimes quite sensitive to noxious odors, and we were sometimes much amused to see them rush about in disgust to escape some very disagreeable odor.

They make no canoes, but are satisfied with small rafts sufficient to float their cocoanuts or mano down the river.

The Bororó are the tallest of any South American Indians I have seen. I do not remember one man under five feet seven inches, and they are sometimes six feet three or four inches tall. They are full faced, the nose well shaped and not large nor particularly flat, nor are the cheek bones especially prominent. Many of the children and some of the young men are quite handsome.

The tribe is supposed to number between five and ten thousand souls. We visited eight villages and settlements.—Abstracted from Smithsonian Miscellaneous Collections.

Correspondence.

REGULAR WIRELESS SERVICE BETWEEN AMERICA AND EUROPE.

To the Editor of the SCIENTIFIC AMERICAN:

It may be questioned whether any one cause has had so injurious an effect upon the development of wireless telegraphy as the publication, not only in the daily press but in technical papers as well, of almost innumerable incorrect, misleading, and often absolutely false statements in regard to the results obtained.

The correction of such misstatements by an individual is a peculiarly unpleasant undertaking for the reason that the action is almost certain to be misconstrued. On the other hand the fact that such statements have been allowed to go unchallenged has led to perhaps even more regrettable misconstruction. In most cases this duty lies in the hands of the technical journals and in the great majority of cases it is well and judicially done. In cases, however, where the technical journals have not the information at their disposal on which to base a decision the duty must devolve upon the individual.

Such publications injuriously affect the development of wireless telegraphy in two ways. In the first place, it has resulted in tens of thousands of individuals in straitened circumstances losing their savings, and has brought the whole business into disrepute with the public. In the second place, the exposure of these exaggerated and misleading statements has resulted in a general incredulity, which has hindered the development of the art; first, by the fact that the various governments have underestimated the real possibilities of the art and have been led thereby to make such stringent regulations in regard to its operation as to practically suppress commercial working; and, secondly, by causing the officials of the various cable and telegraph companies, who would, if they understood the true situation, be the very first ones to warmly welcome and assist in the introduction of wireless working, to discredit it, to the future injury of their own stockholders.

For this reason, therefore, i. e., the injury inflicted upon the development of the art, and upon those companies engaged in its legitimate exploitation, I desire to correct a number of misstatements contained in an article entitled "Regular Wireless Service between America and Europe" which appeared in a recent number of a well-known technical journal.

1. The statement that on Friday, October 18, 14,000 words were transmitted across the Atlantic is incorrect.

A decimal point has been misplaced, the correct number being approximately 1,400. At 5:17 of that date Glace Bay sent message No. 31 as follows:

"Xs (atmospheric disturbances) here. Stand by ten thirty to-morrow. Gd. nite."

Up to 12:23 P. M. Clifden had sent 17 messages, but after that they did not come through very well, and at 2:39 Glace Bay directed Clifden as follows:

"Try 50 words and repeat it twice. Xs bad;" and after Clifden had sent another message at 2:50, Glace Bay instructed Clifden to keep back its messages and take Glace Bay's.

The length of the messages varied from 88 words, No. 30, addressed to the Morning Leader, London, to six words in No. 21, as follows:

"Plenarily London. By wireless answer. McCawley."

A number of these messages of course were not commercial, for example, No. 27, as follows:

"Keep back Hearst's messages and take *our*. Important."

Several messages were sent in foreign languages, for example, an Italian one from Clifden at 9:20, and a 50-word message sent in French, No. 29, at 3:28, as follows:

"Cdn. Cdn. Here French Sp. No. 29, 50 words. New York to Matin, Paris. Dans nouvelle depeche sur faits ayant provoque envoi escadre et impression Washington concernant envoi correspondant Sun dit on demande dans certains milieux pourquoi government cherche cacher publics Americain European fait bien connu du Japan que envoi flotte est advertissment pour Japan montera que nous n'avons pas peur et somnes prets combattre partout 3, 3, Sp. Sp. Import."

Glace Bay commenced sending this at 3:28 P. M. and, after sending it twice, Clifden at 3:52 called up as follows:

"V.V.V. after Japan——????"

When Glace Bay repeated the latter part of the message, finally concluding at 4:01 P. M.

2. The statement that the work was "admittedly excellent." The general character of the work is partly shown by the above extracts. The transmission varied very considerably. The best work noted was on October 19, when at 2:55 P. M. the following message was sent by Clifden:

"Marconi. Congratulate you warmly on successful transmission of wireless telegrams across the Atlantic. Sidney Buxton."

It was sent twice from 2:55 to 3:05, and the following reply was sent twice by Glace Bay, from 3:09 to 3:17:

"To Postmaster-General, London. By wireless across the Atlantic I thank you most sincerely for your kind telegram just received by same medium. Marconi."

This message and its reply took 22 minutes and contained 38 words exclusive of the service words of 54 including these.

Quite a number of messages had to be repeated half a dozen or more times, for example, message No. 21 on October 18, as follows:

"To Louisvient, London. Shaughnessy interviewed Vancouver. Said couldn't understand opposition Japanese believed many respects equal whites. Reaffirmed promise fastest Pacific service. Ca. Hamilton."

This was repeated from 11 A. M. to 11:45 A. M., before Clifden finally O.K.'d it.

Messages Nos. 25 and 26, containing 50 words, to Lusalent and Heybourne and Croft, took from 11:58 to 12:34. Message No. 31, containing 52 words to Express, London, took from 4:40 to 5:26. All the above messages were on October 18.

On the 17th instant a message to the "Times, London," from a gentleman who stated that he had crossed over with Marconi on the "St. Paul" in 1901 was sent six times at 1:20, 1:56, 1:60, 3:11, 3:32, and 3:39.

Another 14-word message inquiring about the weather, signed Regan, of the Associated Press, to McCollins, 24 Old Jewry, London, was sent six times between 5:58 P. M. and 6:47 P. M.

3. The statement that 20 words per minute or 1,200 per hour were sent.

The actual rate was three words per minute, or counting repetitions as original messages, seven words per minute.

The actual rate of operation may be seen by the following records of work on October 14, when messages began to be exchanged (an exceptionally unfavorable example) and October 29 (an exceptionally favorable example).

October 14.

2:26 P. M. Glace Bay says: "No. 13. Gb. to Cdn. Hall, care Expanse, London. To avoid possible risk through suddenly subjecting machinery to continuous running, think desirable conduct first few weeks day service only of say twelve hours telegraph through *Clifden*. Number of words as arranged remain good. Sig. Marconi."

This was sent twice at a rate of seven words per minute between 2:26 and 3:08.

3:08. Glace Bay repeats message again twice.

3:45. Glace Bay repeats above message once more.

4:15. Glace Bay repeats above message once more.

4:56. Glace Bay repeats the message from commencement down to the words "through suddenly subjecting," three times and Clifden O.K.'d it and asked for some information.

October 29.

3:55 P. M. Clifden says: (Calls Gb several times, Rd. Ed. O.K. Rd. heres Dh.) Sd. hnr. —— West Strand. To Marconi. To what number of words per *diam* are you prepared to increase press service? Hall. To what number of words per *diam* are you prepared to increase press service? Hall (3:55).

4 P. M. Glace Bay says: O.K. Rd. Rd. Sd. hnr. 9 Gb. Hall, Expanse, London. Five hundred words per day each way must not be greatly exceeded until my return. Marconi. Nil. Nil. (4:02.)

4:02 P. M. Clifden says: Makes few V's. Calls Gb. "U. send it be breatly. U send it be breatly isnt it greatly. Greatly. Rd. Rd. Rd. Hang on tis. 3. Con." (4:07.)

4:12 P. M. Glace Bay says: 3. 3. 3. Cdn. 7 Greatly 7 Greatly O.K. heres. Dh. Sd. Hnr. 1dh. Nr. Ten. Gb. 47.

To *Bamadyne*, Grand Hotel, Harrogate. Thanks for telegram sorry meeting not yet fixed do not understand how press silent on wireless as we have been sending daily messages from start to Mail Morning Leader Telegraph Chronicle Standard Matin and others also the other way for American papers. Marconi. 3/N.N.N.N.G. (4:30 P. M.)

4:24 P. M. Clifden says: Makes few V's Calls Gb. O.K. Rd. Rd. Rd. Nothing here yet. Nothing here yet. G. G. G. G. Cdn. (4:25 P. M.)

4:30 P. M. Glace Bay says: Sd. Hnr. Nr. Eleven. To. Entwistle. Cdn. Inform Solari he must apply to me for particulars. Marconi.

Nr. AA. Gb. Entwistle. Cdn. Inform Solari he must apply to me for particulars. Marconi. N. N. 3. (4:35 P. M.)

4:37 P. M. Clifden says: Gb. Gb. Gb. OK. Rd. Rd. Rd. Nothing here. Gone it is. Cd. (4:38 P. M.)

4:42 P. M. Glace Bay says: O.K. Sd. Hnr. 12. Gb. To. Entwistle. Cdn. Have noticed here on several occasions *Varves* suddenly going wrong and losing sensitiveness through apparently becoming too conductive for oscillations this often cause of weak signals find reducing voltage sometimes restores sensitiveness. Please ask Woodward keep sharp lookout. Marconi. (4:48 P. M.)

4:53 P. M. Clifden says: Calls Gb. OK. Rd. Rd. Rd. Becoming G.G.G. Cdn. (4:54 P. M.)

4:57 P. M. Glace Bay says: ? ? ? Becoming too conductive ? Becoming too. O.K. Non Non *sang on wat*. 3. (4:59 P. M.)

5:05 P. M. Clifden says: O.K. Rd. Rd. Rd. Tnks. Tnks. (5:04 P. M.)

5:15 P. M. Neither sending.

The messages given above both from Glace Bay, Nova Scotia, and Clifden, Ireland, were received by two operators at Brant Rock, Mass. Some were also received by the company's New York operator, and some were received at the Brant Rock station on the automatic recorder used at that station when operating at rates of 250 words per minute and upward. The messages were taken down exactly as received, including spelling.

Clifden was spelt with two *f's* the first few days and later changed to one *f*. Where two *f's* were sent the word is underscored to show that it was probably a mistake. Similarly, "*Varves*" should probably be "valves."

No method of secret sending was used either at Glace Bay or Clifden. Although there are more than a dozen wireless stations in the neighborhood of Brant Rock, owing to arrangements for cutting out interference and atmospheric disturbances the messages from Clifden were (it will be seen from the above) apparently received better at Brant Rock than at Glace Bay. Glace Bay and Clifden have not exactly the same wave length, and the shape of the wave would not be considered up-to-date, being much broader than is advisable for cutting out interference and atmospheric disturbances. The wave used at Clifden is slightly the better.

4. It will be seen from the above that the statements made by some technical papers to the effect that commercial wireless telegraphy has been inaugurated across the Atlantic are premature. This of itself would perhaps not be of so much importance but for the injurious effect which such premature statements have on the real development of the art. After the publication by the National Electric Signaling Company (Electrician, July 26, 1907, and Electrical Review, September 6, 1907) of the fact that the daylight absorption could be overcome by the use of frequencies lower than 90,000, and that communication had been maintained by the National Electric Signaling Company across the Atlantic from north to south, i. e. from Massachusetts to the West Indies (a distance of 1,700 miles, or within a few per cent of that from Newfoundland to Ireland) for three months during daylight, and at the rate of 25 words per minute, and the statement that this discovery meant that wireless telegraphy across the Atlantic from east to west was merely a question of licenses, it was evident that one of the chief difficulties had been removed, and the fact that Signor Marconi has been able to transmit messages over this distance through using a frequency of 70,000 per second is an interesting confirmation of this discovery.

It must, I think, be admitted that there is at the present time no operation which can properly be called commercial in the same sense in which we speak of the commercial working of cables. While the boldness of the Marconi company in making this claim may possibly be admitted, it cannot fail to have an injurious effect upon the development of wireless telegraphy in general; and it must be remembered that working at the present time of the year is particularly easy, for the atmospheric disturbances which form one of the chief difficulties in wireless operations during the summer months have almost entirely disappeared by the end of September. The system as at present installed is not capable of commercial operation, and is very far behind the times in the following respects:

a. Slow speed: Wireless messages were transmitted across the Atlantic nearly two years ago in the presence of independent experts at the rate of 25 words per minute at night time, and from Massachusetts to the West Indies at the same rate in daylight, in the spring and summer of the present year. Even assuming that the speed of the Glace Bay and Clifden stations can be raised from the present 7 words per minute up to 20, a speed of 250 words per minute per wireless circuit has been reached at other transatlantic stations. Using 12 circuits per tower, which has been done, though not all simultaneously on account of lack of apparatus, this would be equivalent to more than 30 transatlantic cables working at a rate of 80 words per minute.

b. Lack of secrecy: While it is true that anyone familiar with Morse can read telegraph messages by going into a telegraph station, or can read messages passing over a wire from a loop in an adjoining field, and that secrecy has not been found in practice to be a very important feature in regular telegraph work, and while the most important messages would be sent in code, it is nevertheless preferable that wireless stations should use a system of secret sending such as the "scissor" method or some similar device, which would at least not force the messages upon the attention of other stations. Of course, if messages are sent at a high speed, say 250 or 400 words per minute, this of itself renders it very difficult to tap messages, and in practical working may be sufficient, but at least one of these methods should be used.

c. Liability of interference: While it is true that wire telegraphy and telephone lines may be interfered with maliciously, and while undoubtedly malicious interference with wireless systems would be dealt with by the courts in the same way as wire lines, it is nevertheless advisable that wireless stations should not be liable to unintentional interference, and preferably that they should be protected against malicious interference. There are a number of ways in which this can be done, as was shown, for example, by the U. S. navy official tests some years ago at New York, where it was found impossible to produce interference with a station 226 yards away from the receiving station, and some such method should be used.

d. Atmospheric disturbances: Means should be provided for protecting wireless stations from atmospheric disturbances to at least the same extent as cables are. A cable can operate up to within a half hour of the arrival of a lightning storm, and some of the well-known means for achieving this protection should be used for wireless stations. If it is not done operation becomes impossible in the summer months, as with long-distance stations there is always some thunder storm within the radius of operation.

e. Facilities for distributing messages: Wireless companies intending entering the field of commercial cable work must be prepared to deliver their own messages. This means that the system must be capable of operating economically and reliably over land. Fortunately, the matter of land operation in connection with cable work is not so important as has been claimed, for the reason that investigation has shown that 70 per cent of all cable messages in the United States come from ten large cities. Any wireless company therefore which did not have a system capable of working over land (though in parenthesis it should be said that such systems are in existence) would have no difficulty in putting down trunk lines and getting sufficient inter-city business to pay for their maintenance, and leave the cable distributing business clear profit, since in inter-city business the capital invested in lines per message per year is much smaller than that in the case of feeders. The question of making arrangements with telephone companies for distributing messages is one which might be taken up if desired, though the inter-city messages and the cable messages will probably always constitute the cream of the business.

In what has been said above it should be clearly understood that there is no intention of reflecting upon the officers of the Marconi company. Unfortunately, these officers have doubtless been unable to control as fully as they would have liked the various exaggerated statements which have appeared in the press. The writer has gone to considerable personal inconvenience in avoiding interfering in any way with the experiments at Glace Bay and Clifden. For example, on October 15 the following message was received at 2:48 P. M.:

"No. 14. Ms. GB: To Hall care Expanse, London: I propose commencing service for transmission and reception Thursday Clifden working hours eleven A. M. to eleven P. M. G. M. telegraph if all right. Marconi."

Instructions were at once given to the operators at the Brant Rock station not to do any experimental sending work during the balance of that week and to use the non-interfering system or wireless telephone for all communication with New York.

5. The historical statements are in many instances not correct. It is not a fact that *D's* were received in Newfoundland between 3 and 6 P. M. in December, 1901, from Poldhu, using a single untuned wire 400 feet high. The fact that a coherer can be made to give a series of clicks of any desired number when connected to an antenna and there is a wind blowing has been known to wireless experimenters for some time. Doubtless Signor Marconi at the time considered that he was receiving *S's*, but from the above examples of the difficulty in reading messages using 250 horse-power, and with enormous capacities and receivers more sensitive even than the magnetic receiver, and with tuned circuits, as at present used at Glace Bay and Clifden, anyone can form an opinion for himself whether messages were received with 10 kilowatts energy, a single untuned wire 400 feet high, and a carbon coherer. It is also not correct that the Anglo-American Cable Company prevented the continuance of these experiments. I have no acquaintance or relations with the officers of the Anglo-American Cable Company, and no relations and but slight acquaintance with the officers of any other cable company, but shortly after this statement was made the Anglo-American Company published the correspondence on the matter, from which it would appear that they had merely entered a formal protest against the infringement of their monopoly as regards commercial working, and according to correspondence as published they specifically went on to state that they had no objection to Signor Marconi carrying on any scientific experiments that he wished. As this correspondence was published and has never been controverted, it may, I think, be taken as correct.

With reference to the transmission of the message from the President to King Edward in January, 1903, the fact that this message after its receipt at Holland House was transmitted by cable has been common knowledge for some time. Four different explanations have been given at different times as to why no return message was sent, in view of the statement that Poldhu was in communication with Wellfleet and acknowledged receiving the message, but the following cablegram will show that Signor Marconi cannot be held in any way responsible for such statements:

"No. CB 20. Check 23. Wellfleet, Mass. Cable message. W. U. Telegraph Co. Duxbury, Mass., 1—19—1903, 1:34 P. M. A-A. No. 31. Sent 6:36 P. By E. Wellfleet, Mass. Expanse, Ldn. President's message to King despatched successfully from Cape Cod to Poldu direct and also via Capebreton you may publish text immediately. Marconi."

It will be noted that the cablegram makes no mention whatever of any communication from Poldhu, and it can hardly be supposed that the cable would have been used had there been any knowledge on this side of the Atlantic as to whether Poldhu had received the message or not.

The question has several times been raised as to why wireless telegraphy has not come into commercial use, and it may be well to give the answer here. The reason is that up to the present time it has been absolutely impossible for any wireless company outside of the Marconi company to obtain permits for commercial operation. The following brief statement of some of the attempts which have been made by one company to obtain permits will explain the situation in the clearest way:

1. Application made for working in Great Britain. Granted through the kindness of the Postmaster-General a few months ago, too late, however, to permit of the erection of stations this year.

2. Newfoundland. Rejected on account of exclusive license given Marconi for ten years.

3. Sable Island. Applied for in 1902. Later allowed to Marconi.

4. Bermuda. Applied for at various times since 1902, backed by petitions signed by principal merchants. Up to date refused.

5. Jamaica and other West Indian Islands. Refused.

6. Cuba. Granted on condition that company should purchase land and erect station, and that after this had been done the tolls for messages and taxes would be determined by Cuban government.

7. France. No reply.

8. Spain. No reply.

9. Australia and New Zealand. Refused.

10. Brazil. Stations constructed and operated successfully experimentally, but permit for commercial working refused.

The above brief statement of the results of some of the applications made for permits to operate commercially will explain sufficiently and completely the reason wireless telegraphy is not at the present time in commercial operation.

As to the reason why it has been impossible to obtain these permits, I consider that this is due primarily if not entirely to the publication of exaggerated and untrue reports as to results obtained. From a business point of view it may be good policy for a company to consistently represent that it has accomplished results before it has actually done so, and to trust that the fact will not be discovered until after its possible rivals have actually obtained the results and their apparatus and methods are at its disposal. Unfortunately, this has led to a general incredulity in regard to the possibilities of the whole art; and under the circumstances, however oppressive and detrimental to the progress of the art we may feel the restrictions to be which have been proposed by the various governments, we cannot rightly blame the responsible officials for their attitude. What we must hope for is a severe censorship on the part of the various technical journals in regard to statements of results obtained, so that in time a knowledge of the real state of the art may be at the disposal of the various government officials concerned. If the present note, which has been written with great reluctance, shall have any influence in bringing about this result the writer will feel that it has not been written in vain.

REGINALD A. FESSENDEN.

Brant Rock, Mass., November 4, 1907.

ENGINEERING NOTES.

El Estado of Bolivia, for June 21, contains particulars of a concession to construct a Decauville line from Corocoro to Calocoto and a railway from Chacasilla to San Juanillo. The concessionaire is also authorized to construct telegraph and telephone lines for the railways.

Col. H. E. Kitchener, an elder brother of Lord Kitchener, who resigned from the British army to become a Jamaican planter, suffered during the recent earthquake, and has now designed a method of building which he considers quakeproof. He has decided to build a house with walls composed of rows of drain pipes placed on end and filled with cement between, with a casing of cement on the outside and thin wood inside. He declares that this combination will resist any earthquake.

Important researches upon the use of high-pressure steam—up to about 1,500 pounds per square inch—in steam turbines have been conducted by Dr. de Laval. He finds that the present tables giving the properties above 350 pounds pressure—432 deg. F.—are unreliable, the values having been extrapolated. One remarkable deduction is that at about 640 deg. steam seems to have a maximum efficiency. This is apparently paradoxical, for theoretically the thermodynamic efficiency is greater the higher the temperature. The probable explanation is the rapid decrease in the latent heat as the critical temperature—689 deg., according to Cailletet; 698 deg., according to Regnault—is approached.

The author of a recent article on the interchange of heat in steam-engine cylinders takes the example of a steam engine running at 300 revolutions per minute, and argues that, as the entire stroke is covered in one-tenth part of a second, there is not time for any interchange of heat between the metal and the steam. Experiments said to be analogous are quoted in support of this view of slow interchange of heat, and the author concludes that it is the water of condensation acting directly on the entering steam which is the real agent of the so-called interchange of heat losses, and that this action is greatly assisted by the free mixture of the products of compression with the entering steam.

In order to facilitate the collection and delivery of letters and packages in Vienna, the Ministry of Commerce is engaged upon a plan for an underground electric railway, which would link together the chief and various district postoffices of the city, which number about sixty-four. According to the plans which are now under discussion, the line would be built 25 feet below the surface of the ground, and the tunnel would have a height of 5 feet and a breadth of 4 feet 4 inches. The stations would be built underneath the postoffices. The trains would run at 20 miles an hour, and would consist of a motor and three cars, each carrying as much as the ordinary post van. It is estimated that it would take seven years to construct the line, while its cost would be enormous.

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